

Marine Engineering

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No. 12.

HAVANA FLOATING DRY-DOCK NOW AT NAVY YARD, PENSACOLA, FLORIDA.

The passing of the Havana dry-dock, built for the Spanish Admiralty for use in Havana harbor before the late war, from one country to another and from one port to another, its collapse, repair, and final successful use, makes as interesting a chronicle of events in the life of an ordinary dry-dock as could be found in the history of many a merchant or war ship.

on-Tyne, while the designs were prepared by Clark and Standfield. It is of the usual self-docking pontoon type, composed of two side walls and five pontoons. Each side wall and pontoon is divided into five watertight compartments; thus there are thirty compartments in all. Any pontoon can be raised by the others, thus facilitating repairs and cleaning, while the bottom of



10,000-TON FLOATING DRY-DOCK NOW AT PENSACOLA NAVY YARD, WITH FREIGHT STEAMER AUGUST BELMONT.

Before the dock was finished Cuba as well as the Philippines came under our protection, and Spain had no more use for the dry-dock, so in 1901 our government decided to purchase this dock as an expression of our friendly post-bellum feeling for Spain. It was primarily intended to tow the dock to the Philippines, but this plan was changed as it was decided to build a larger one for that service. The government continued using this dock at Havana successfully for some time until it became necessary to clean the pontoons.

The dock was built by C. S. Swan and Hunter, Limited, at Wallsend-on-Tyne, and the machinery was installed by Ernest Scott and Mountain Smith, Newcastle-

the side walls may be reached for the same purpose by simply careening. In this manner the whole structure may be kept in first-class condition. The dock has adjustable bilge blocks, capable of being shifted in or out as well as longitudinally.

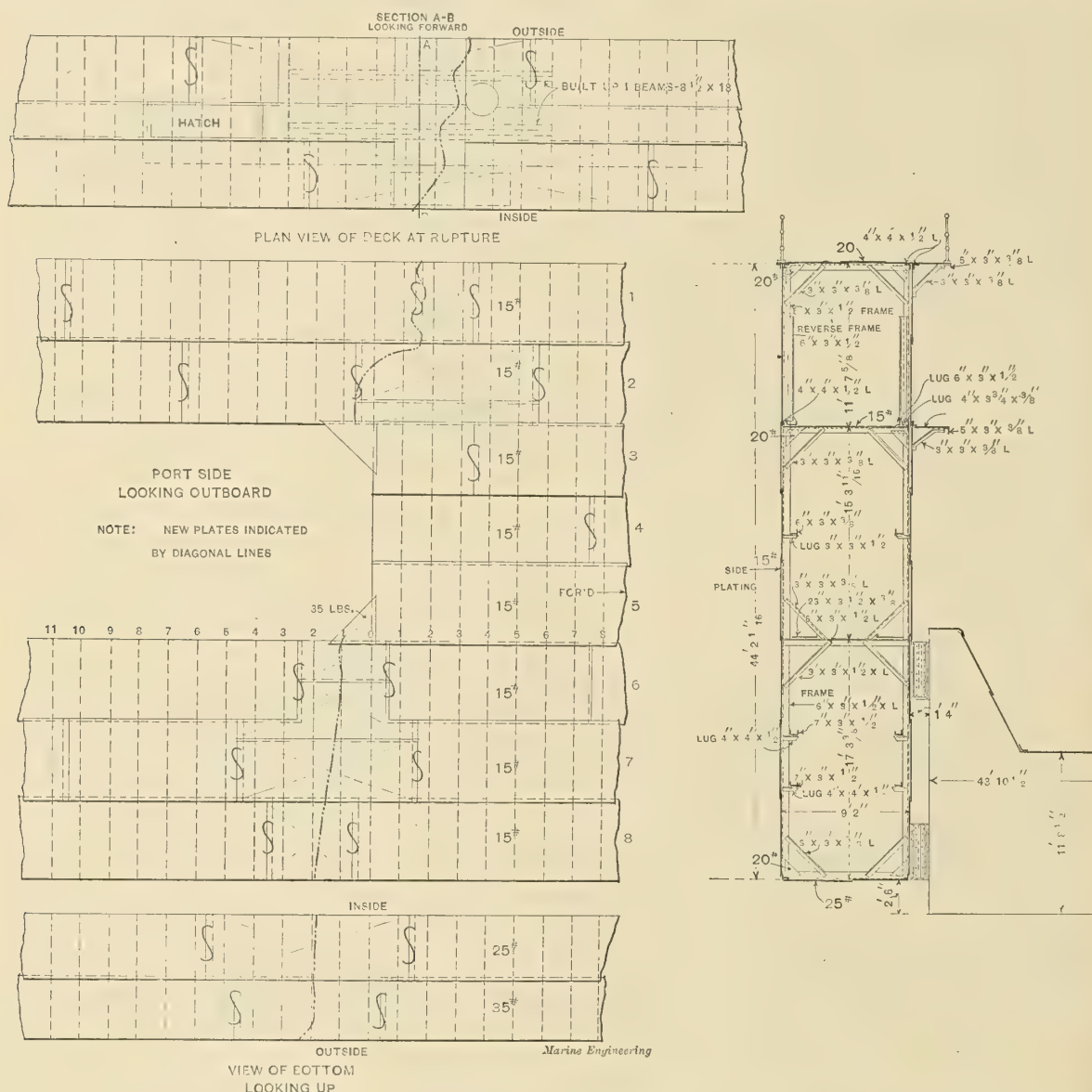
The general dimensions are as follows: length over all, 450 feet; breadth inside of walls, 87 feet 7 inches; water over sill, 27 feet 6 inches; number of pontoons, 5; weight, 4,400 tons; lifting capacity, 10,000 tons. The plating is of 15 pounds weight, while the angles are 6 by 3 by 10-20 inches, well secured by numerous brackets. A sketch may be seen on page 598. The machinery consists of two 200-horse-power locomotive

boilers supplying steam to two vertical, compound engines direct-connected to 125 Kw. direct-current, 400 volt, shunt-wound generators. The current is used for driving ten 25 Kw. series-wound motors, each connected to an 18-inch centrifugal pump.

The working of the dock is done from two central positions or valve houses, one on each wall, where are grouped all the levers for opening and closing the dif-

ferent valves. Each valve house is in direct communication with the engine room, so that the man in charge can manipulate everything for maneuvering the dock without quitting his station.

When it became necessary to clean the pontoons, doubt was expressed concerning the structural strength; for, owing to the fact that when the pontoons were uncoupled there was no way of pumping them out, it would be necessary to raise them full of water. It was decided, however, to undertake the work, the intention



VIEWS SHOWING THE RUPTURE, METHOD OF REPAIRING, AND THE CONSTRUCTION OF SIDE WALL OF HAVANA DOCK.

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accompanying sketch, which also illustrates the method of patching and stiffening.

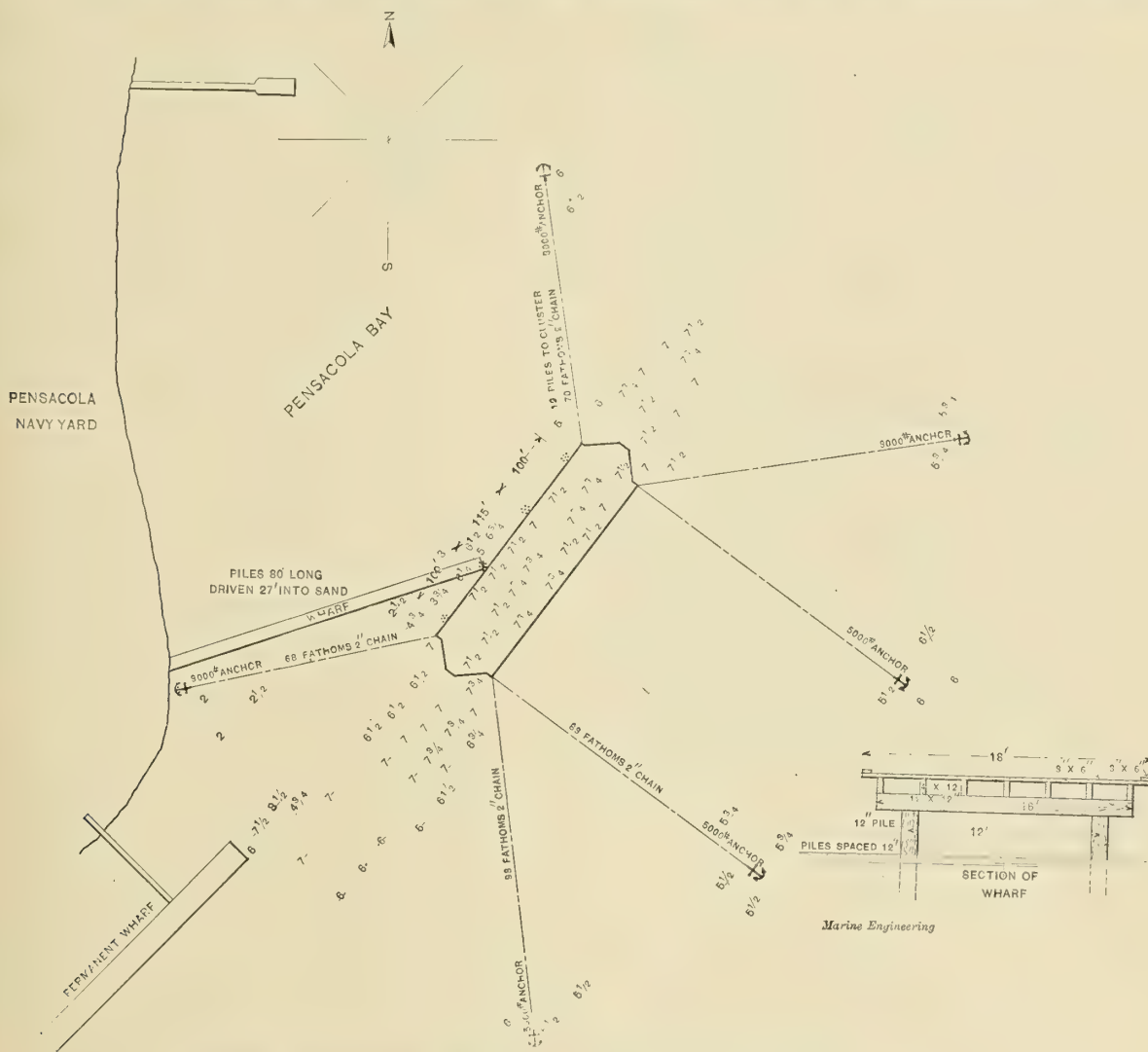
This was a very serious accident, especially in view of the fact that Pensacola was the nearest port where such an extensive repair job could be undertaken. The Navy Department decided that the two parts should be towed to the navy yard at Pensacola, and accordingly contracted with the Boston Towboat Company for that work. Under the direction of Assistant Naval Constructor Du Bose, the tug *Underwriter* and steamer

Orion, of the towboat company, brought the two parts across the gulf in November, 1902, and anchored them off the yard with only the loss of one of the small end caissons.

In January of this year the repair was started. The top plates of the side walls had parted across and sheared the rivets, and the sides had ruptured in the same way, but on the under side the plates were crumpled up like paper. To perfect the repairs the two broken ends were brought together and patches put on

and one opposite each gangway. At the two latter points the dock is further secured to the piles by a chain and shackle. All of these precautions are necessary owing to the strong winds that sometimes blow in from the gulf, and the very strong tide running in and out. A wharf was built from the shore out to the dock, and a gangway board runs from the outer end of the pier to the opening in the dock.

The first trial of the rebuilt structure was made on September 5, when the Gulf Transportation Company's



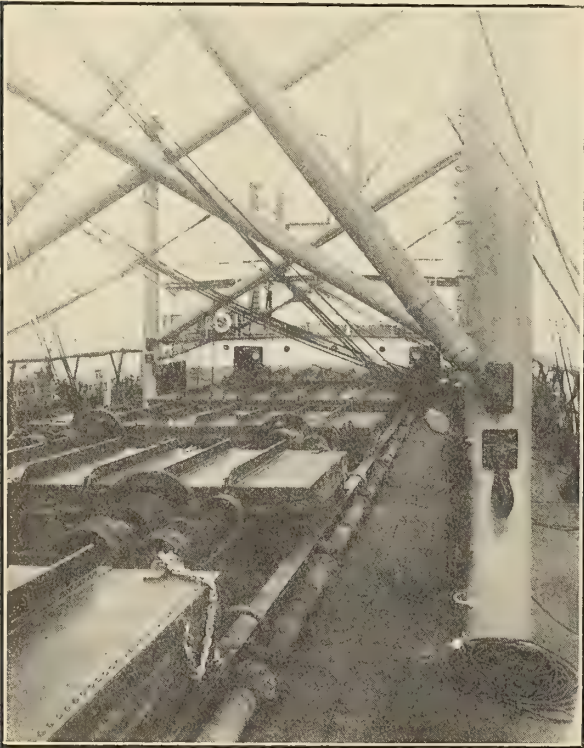
LOCATION AND METHOD OF ANCHORING THE FLOATING DRY-DOCK AT PENSACOLA NAVY YARD.

as shown. The navy yard had at this time not taken on its present boom, and the stock of plates was low, nevertheless a strong job was made. At the same time all parts of the dock were overhauled, machinery taken down and set up, new chain shackles made, and the dock painted. It was then towed out into seven fathoms of water and moored by six 2-inch chains made fast to a corresponding number of anchors ranging from 3,000 to 5,000 pounds in weight, with the flukes of the inshore anchors further secured by having piles driven on the inside. Along the inshore side of the dock there are four nests of 80-foot piles, one nest at each end

and one opposite each gangway. At the two latter points the dock is further secured to the piles by a chain and shackle. All of these precautions are necessary owing to the strong winds that sometimes blow in from the gulf, and the very strong tide running in and out. A wharf was built from the shore out to the dock, and a gangway board runs from the outer end of the pier to the opening in the dock. The first trial of the rebuilt structure was made on September 5, when the Gulf Transportation Company's

cargo steamer *August Belmont*, of about 4,000 tons displacement light, was successfully docked and painted. The accompanying photograph shows the *Belmont* in the dock. Another is a deck view of the steamer, from which the closely-spaced hatches and cargo derricks on either side are most conspicuous. The *Belmont* is a large steamer of the latest type, built at the yard of Swan and Hunter. She is employed as a collier between Pensacola, Fla., and Tampico, Mexico. At the time of the docking she drew 14 feet aft and 6 feet 3 inches forward.

Captain F. W. Dickens, commandant of the eighth naval district, which embraces Pensacola, is endeavoring to have the Pensacola navy yard thoroughly equipped with modern machinery and buildings. Besides the 10,000-ton dock, there is a small one capable of docking a ship of 6,000 tons. The harbor is an ideal place for a naval station, with deep water and plenty of room for anchoring all the vessels of our Navy. Only until recent years has the government property been improved.



CARGO DERRICKS AND HATCHES ON THE AUGUST BELMONT.

New System of Water-Tight Bulkhead Doors.

The Hamburg-American line is fitting on the bulkheads of several of its vessels the patent Stone-Lloyd system of hydraulically-operated doors. The steamship *Deutschland*, which sailed from this port recently, has all of the twenty-eight bulkhead doors below the water line equipped with this system. The doors may all be closed or opened from the bridge, and each individual door may be closed separately by hand levers on either side of the bulkhead. Another valuable feature is that should the compartment near a water-tight door become filled with water, that door is automatically closed by a releasing device operated by a float placed in a tank open to the bilge.

The doors are operated by hydraulic power, which is supplied by a duplex pump and a pair of steam accumulators, giving a working pressure of 700 pounds per square inch throughout the system. The fluid is a mixture of water and glycerine, which fills a pressure main leading from the bridge to each of the doors. There is also a drain or a return pipe led to each door, and across these two pipes each of the cylinders oper-

ating the doors is connected. The operating device on the bridge is a very simple one; but before the doors can be closed, alarm bells are rung throughout the ship to fifteen seconds to warn all persons of the intended closing of the doors. The mechanism is quite simple and consists of an hydraulic cylinder on whose ram a ratchet is cut. This ratchet engages a pinion, which in turn, through another pinion, drives a ratchet affixed to the bulkhead door. The pressure admitted above the ram closes the door, and similarly, if admitted below the ram, raises the door. The controlling valve is operated by pressure in the mains, regulated from the pilot house, and admits the fluid either under or above the ram.

The system has this special and most valuable feature, which is that, if the doors are closed from the bridge, any individual door may be opened from either side of the bulkhead, thus providing a means of escape to any of the crew who might be imprisoned behind the door; yet the device is so arranged that this door will automatically close itself again. The power for closing the door is sufficient to cut through a pile of coal, should the doorway be choked up with fuel. As it closes it is forced hard against the bulkhead by wedges in the door rim, and is thus made water-tight. From the inventor of this system, Mr. Ralston, a further description is expected.

NAME—August Belmont. LAUNCHED—1902.	NATIONALITY—British. BUILDER—Swan and Hunter.	TYPE—Cargo steamer. OWNER—Gulf Transportation Co.
Length over all..... 388 ft. 0 ins.	Propeller : Number of blades..... 4	
“ between perps..... 372 “ 0 “	Diameter..... 17 ft. 6 ins.	
Breadth..... 50 “ 6 “	Pitch..... 18 “ 3 “	
Depth of hold to upper deck..... 30 “ 6 “	Area..... 98 sq. ft.	
Draft, load..... 24 “ 0 “	Boilers : 3 single-end Scotch	
Displacement, load..... 10,870 tons	Diameter..... 15 ft. 7 1-2 ins.	
Dead-weight carrying capacity..... 6,900 “	Length..... 10 “ 0 “	
Block coef..... .72	Steam pressure..... 185 lbs.	
Number of cargo booms..... 16	Tubes, diam..... 3 1-4 ins.	
Engine : Type..... 3-cylinder, triple	Furnaces..... 3 each	
Cylinder diams..... 26, 43, 72 ins.	H. S..... 7,800 sq. ft.	
Stroke..... 48 “	G. S..... 240 “ “	
Shafting diam..... 14 3-4 ins.	H. S. + G. S..... 32.5	
I. H. P..... about 2,000	H. S. + I. H. P..... 3.9	
Cooling surface..... 3,000 sq. ft.	I. H. P. + G. S..... 8.3	
Air pump..... direct-connected, 24 ins.	Draft..... closed stokehold	

STARTING LARGE GAS ENGINES.

BY E. W. ROBERTS, M.E.

The manipulation of a small gasoline marine engine is a comparatively simple matter and it requires no great manual effort to turn the engine over until it takes up its cycle. In large engines, however, it requires more than an ordinary man's strength at the starting crank to turn them over with sufficient rapidity for them to take up the cycle. Quite a number of different schemes have been used in the past in order to make it easy to start large engines. Among these may be mentioned a set of reducing gears with a ratchet which releases as soon as the engine gets its impulse. Another consists in allowing a portion of the explosive mixture to escape on the expansion stroke, and this pressure is stored in a tank to be used for giving the

fitted and the pistons and piston rings given a good fit in the cylinder, a charge of gas and air will be held for a long time after stopping. This charge may be used for giving the initial impulse by first turning the engine over past the center and producing a spark at the igniter.

Quite a number of auxiliary devices have been developed from time to time, some of which are still in use by various makers. Among these are pumps for charging the engine with gas and air with which to give the starting impulse, and various forms of igniting mechanism in which the charge may be fired by an ordinary parlor match.

A good example of a detonating device is shown in Fig. 1. This starter consists of a steel body, *B*, which screws into the compression space of the engine. In the top of the engine is the plunger, *d*, with corrugated taper head, *A*, and at the outer end of the shank the cap *C*. The spring *S* keeps the plunger against the neck of the body on the inside, to which it is ground to form a tight joint. When about to start the engine an ordinary parlor match is inserted through the cock, and the plug *h* turned so as to grip it. About a teaspoonful or more of gasoline is put into a priming cup and a charge drawn in with the engine at the expansion stroke, and all the valves, closed, air to fill the cylinder being drawn in through the priming cup. When the stroke is nearly or quite completed, the engine is reversed swiftly and turned as far as the compression and strength of the operator will allow. Just as the piston begins to stop, a blow of the hand on the cap *C* causes the plunger *A* to light the match and fire the charge. The resulting impulse is usually sufficient to carry the engine through three or four revolutions, which will allow it to take up its cycle. After the engine is started the plug *h* is turned and the explosion blows out the burnt match.

The use of the match for starting an engine is not, as a rule, necessary with an electric igniter, and it is a very simple matter to arrange the hammer break so that the spark can be produced by the blow of the hand; and with a jump-spark system a push button may be connected in a primary circuit of the coil, so that by pressing the button the circuit will be closed and a spark produced at the plug. A three- or four-cylinder engine fitted with jump-spark ignition is usually ready to start by simply closing the igniter switch and turning the spark advancer until a spark is produced in the cylinder which is nearest the top of the stroke. In general it may be said of this system of starting that the igniter switch should always be opened before closing the throttle, and the engine stopped in this way. There should always be a charge left in one of the cylinders to use for the next start.

In order to assist the operator it would be a good plan to mark the flywheel, say with a steel stamp, putting a 1 on the rim in line with the crank pin on the forward cylinder, and a 2 in line with the crank pin of the next cylinder aft, and so on for the other cylinders. This will indicate, by the number, which piston is nearest to the upper dead center and which cylinder should be used to start the engine. When ready to start, see that the flywheel is in a position such that one of the numbers indicates a certain piston to have

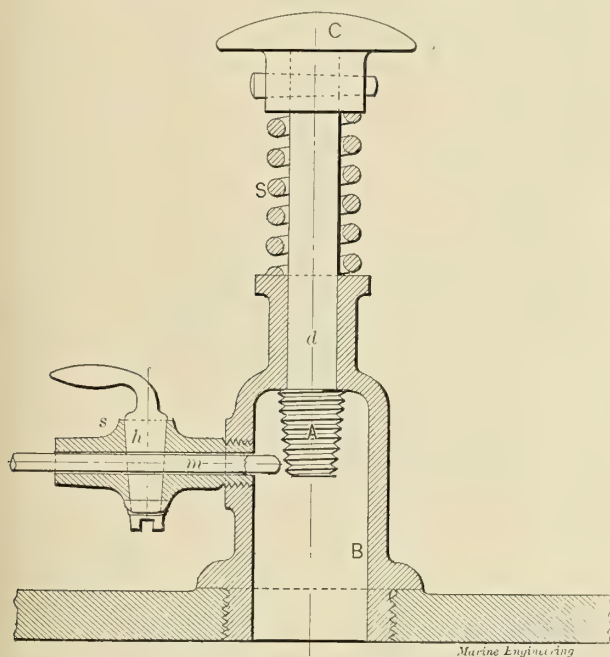


FIG. 1.

starting impulse to the piston the next time the engine is used, the engine running temporarily as an air engine. A still further development of this scheme is to install a small air compressor geared to the engine which is used to charge the tank, and the compressed air employed to start the engine as in the system just outlined.

In a very large engine where the horse power runs up into the hundreds, a small engine is connected with the large one to give it the starting effort through a system of gears. This engine, known technically as a "barring engine," can be readily started by hand, and when it gets up to speed it is thrown in connection with the large engine by means of a clutch, and the small engine used to start the large one. A still later development in starting mechanism is to charge the cylinder with a mixture of gasoline and air, to turn the engine over by means of a lever until the piston is just past dead center, and then to ignite the mixture by means of a detonating mechanism. In the modern multiple-cylinder engine, where the parts are accurately

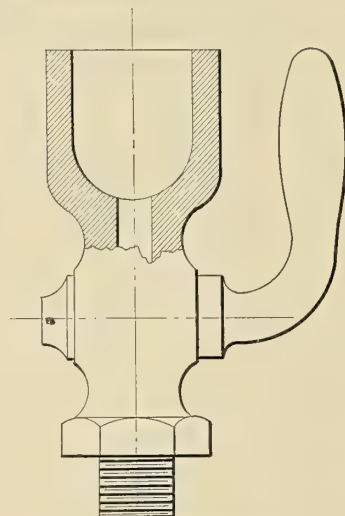
just passed the upper dead center; then ignite the charge in that cylinder, having, of course, made all the usual preparations for starting. That cylinder should get an impulse which will carry the crank shaft round until one or more of the cylinders can take up the cycle.

If it is found that the cylinder will not hold a charge for any length of time, or the engine has been lying idle so long that the gasoline vapor has all escaped from the cylinders, it may be charged by means of a priming cup, of which an example is shown in Fig. 2. The priming cup allows the charge of gasoline to be measured, and is filled, according to the size of the engine, either once or twice in order to allow a certain amount of liquid gasoline to enter the cylinder for enriching the air in order to make an explosive charge. The amount of gasoline to be used for priming will have to be found by practice, and it should be remembered that in warm weather, or when the engine is hot, less gasoline is required than in winter when the engine is cold. The reader should remember that with a cold engine, only the lighter portions of the gasoline are likely to evaporate, the balance being blown out from the exhaust by the first explosion. The proportion which is evaporated increases with the temperature of the engine; and when the engine has just been shut down and is quite warm, perhaps all of the priming charge will be evaporated. In a two-cycle engine, quite frequently rocking the flywheel back and forth with the piston near the bottom of the stroke will serve to pump a charge of gasoline and air into the cylinder from the vaporizer; and then by throwing the wheel backward until the piston is near the top of the stroke, and snapping the igniter, the engine will receive a starting impulse.

Quite a number of marine engines have been fitted with a small air pump operated by a worm and screw from the propeller shaft, and an air pressure between 60 and 100 pounds is raised in the reservoir. This tank is connected, through a quick-opening valve, to the compression space of the cylinders. The engine is started by turning it over until one of the pistons has just passed the top of the stroke, when the valve is opened sharply and the pressure of the air starts the engine. The flywheel or crank shaft must be watched closely and the air shut off before the stroke is quite completed, so it will not retard the piston on the return stroke. Usually one impulse or "kick" is sufficient to start almost any engine; and as the impulse is in proportion to the piston area, the system works very nicely, irrespective of the size of the engine, so long as the air tank is of sufficient capacity. The writer believes that the capacity of the air tank should be at least ten times the piston displacement of the engine.

Recent correspondence on this subject with a large number of manufacturers of marine engines shows that the latest practice is tending toward the use of the igniter for starting. In a few of the very large marine engines a charging pump for filling one or more of the cylinders with a mixture of gasoline and air is used to supplement the igniter. In starting an engine by means of a charging pump, the pump is arranged to draw air through the vaporizer, or else is charged with a certain amount of liquid gasoline and air, and gasoline vapor pumped into the cylinder with the crank pin

in that cylinder just past the upper dead center. So soon as the pressure is sufficient to start the flywheel the charge is ignited and the ensuing explosion gets the engine under way. The reader should note that the starting of the gas engine requires a little practice, and that there is a knack in it, just as with a great many other things in handling machinery.



Marine Engineering
FIG. 2.

Engines of the Italian Cargo Steamer *Selene*.

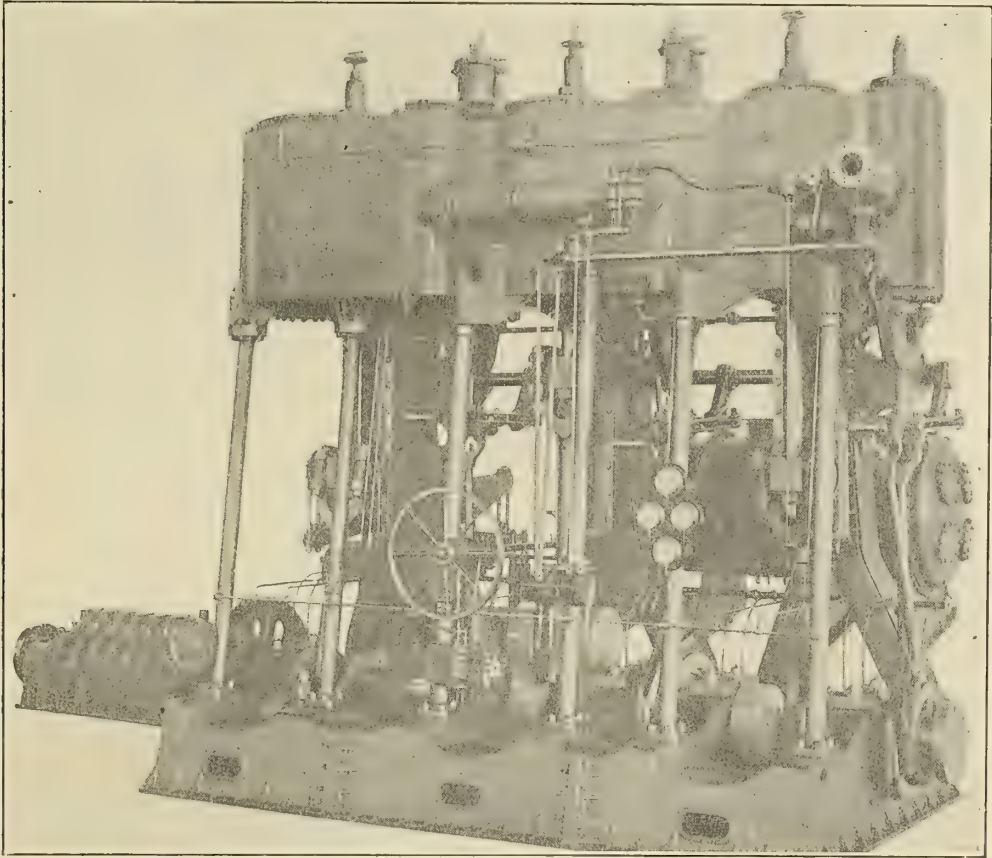
From a correspondent in Italy the following description and illustration is received of the engines of the new cargo steamer *Selene*, built at the yard of the Società Cantieri Liguri Auconitain. She is built under the rules of the Italian Register and also Lloyd's, and is a sister ship to the *Regina Elena*, launched three years ago. The main engine is of the usual triple-expansion type, working on three cranks. The cylinders are of close-grained cast iron and not fitted with liners, therefore without steam jackets. Steam enters the piston valve high-pressure cylinder on the front of engine, and is carried by a copper receiver from the back of the valve to the intermediate valve; a second receiver on the front of engine finally carries the steam to the low-pressure valve. The intermediate and low-pressure cylinders have slide valves fitted with balanced pistons, and all valves are worked from Stephenson double-bar links. All cylinders and valves are thoroughly drained.

The cylinders are supported by six front forged-steel columns trussed by forged-steel stays, and by three back Y columns of cast iron. As seen in the illustration, the engine is most accessible, and presents a light but strong appearance.

The forged-steel crosshead is of the slipper type, with both go-ahead and astern surfaces babbitted. The connecting rods are forked at the upper ends for spanning the crosshead. The brasses are accurately fitted at either end and lined with white metal. The eccentrics are cast iron, made in two parts, and are babbitted on each side for the flanges of the eccentric straps, which latter are of cast iron, in two parts, and lined with white metal. The valve stems and eccentric rods are of high-grade forgings. The crank shaft is of the built-up type and in one section. As will be noted, the condenser

shell is constructed of steel plates, cylindrical in form, and supported on brackets on the back of the high and intermediate columns. Water is supplied by a centrifugal pump, and a vacuum is effected by a direct-acting

the reversing shaft at the back of the engine. The screw propeller is entirely of cast steel, with four right-hand blades. A complete system of both automatic and sight-feed lubricators is installed.



TRIPLE-EXPANSION ENGINE OF ITALIAN CARGO STEAMER SELENE.

NAME—Selene.	NATIONALITY—Italian.	TYPE—Cargo boat.
LAUNCHED—July 20, 1903.	BUILDER—Società Cantieri Liguri Auconitain.	OWNER—Raggio and Sons.
Length over all.....352 ft.	Direct air pump, diameter.. ..20 7-8 ins.	
“ between perps.....335 “	Stroke.....23 5-8 “	
Extreme breadth.....44 1-2 “	Propeller, diameter.....16 ft. 4 7-8 “	
Depth.....29 ft. 7 ins.	Pitch 16 “ 4 7-8 “	
Draft, loaded.....24 “ 7 “	Blades, number.....4	
Displacement, loaded.....8,500 tons	Boilers: Number.....2 single-end Scotch	
Hatchways, number.....4	Diameter.....15 ft. 10 3-4 ins.	
Speed, load draft.. ..about 12 knots	Length.....10 “ 0 “	
Engine: Number.....1	Furnaces: 4 each	
Type.....three-cylinder, triple-expansion	Inside diameter.....39 5-8 ins.	
Cylinder diameters.....24 7-16, 40, 65 ins.	Grate surface 172 sq. ft.	
Piston, stroke.....47 1-4 “	Heating surface.....4,956 “ “	
Valves, “ 7 ins.	H. S. ÷ G. S.....28.8	
Revolutions, designed.....70	Pounds of coal per I. H. P. per hour for	
Condensing surface.....2,260 sq. ft.	sister ship Regina, Elena 1.55	

air pump worked from the low-pressure crosshead. The bed plate is of box pattern, in three sections, bolted securely together. Reversing is accomplished by a vertical steam engine placed on the front intermediate column, which drives a cross horizontal shaft turning

Steam is supplied by two Scotch single-end boilers carrying a steam pressure of 190 pounds per square inch. Both engine and boiler rooms are fitted most completely with auxiliaries, and the machinery is expected to drive the steamer at a speed of about 12 knots.

ELEVENTH ANNUAL SESSION OF THE MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

The eleventh annual session of the Society of Naval Architects and Marine Engineers was held in the rooms of the American Society of Mechanical Engineers, 12 West Thirty-first street, New York, N. Y., on the 19th and 20th of November. The meeting was called to order on the morning of the 19th by President Griscom. The first business taken up was the secretary's report, which was read and accepted. The report shows that there are in all 844 members; that the balance on hand November 17 was \$3,648.64; that the resources amount to \$20,971; and that there are no liabilities. The council submitted the following recommendations for membership, the names were read by the secretary, and the applicants were elected:

Members, 12.—Edward P. Bates, manufacturer and contractor, steam heating and ventilating apparatus, 228 West Water street, Syracuse, N. Y.; Henry Edgeworth Frick, assistant superintendent of hull construction, marine department, Maryland Steel Company, Sparrow's Point, Md.; Robert Haig, surveyor to Lloyd's Register of Shipping, 846 North 63d street, Philadelphia, Pa.; James R. Hampton, superintending engineer, Townsend-Downey Shipbuilding Company, Shooter's Island, N. Y.; James Henry Mancoe, principal engineer surveyor for United States Lloyd's Register of Shipping, 15 Whitehall street, New York, N. Y.; Edward Lasius Peacock, marine engineer for Midvale Steel Company, Nicetown, Philadelphia, Pa.; George Stanbury, principal surveyor, United States Lloyd's Register of Shipping, 15 Whitehall street, New York, N. Y.; Carl Wilhelm Vollman, president Linde British Refrigeration Company of Canada, 301 St. James street, Montreal; William Carlile Wallace, marine consulting engineer, Messrs. John Brown & Co., Ltd., Sheffield, 116 East 17th street, New York, N. Y.; Henri Wilkinson, chief surveyor to the Bureau Veritas, 17 State street, New York, N. Y.; Louis L. Bernier, James H. Mull.

Promotion from Associate to Member, 7.—Ralph Ens-worth Barry, Newport News Shipbuilding and Dry-Dock Company, 111 33d street, Newport News, Va.; David W. Dickie, draughtsman in charge, office of superintending constructor, Moran Brothers' Company, Seattle, Wash.; Thomas Gaines Roberts, assistant naval constructor, Navy Yard, Mare Island, Cal.; Charles H. Thayer, draughtsman, Newport News Shipbuilding and Dry-Dock Company, Newport News, Va.; Johan H. Norman, Cramp's Shipyard, Philadelphia, Pa.; Archibald M. Main, Stuart F. Smith.

Associates, 18.—Karl Eimar Walfrid Alland, draughtsman at New York Shipbuilding Company, 521 Penn street, Camden, N. J.; William H. Balls, draughtsman, Construction and Repair Department, Navy Yard, Philadelphia, Pa.; George Kearney Bradfield, sales and technical department of Vacuum Oil Company, 29 Broadway, New York, N. Y.; Edwin F. Church, Jr., instructor in marine engineering and naval architecture, Lehigh University, Bethlehem, Pa.; James Frederick Clegg, leading ship draughtsman, Crescent Shipyard, Elizabethport, N. J.; Leroy Eugene Caverly, hull draughtsman, superintendent's office, Union Iron Works, San Francisco, Cal.; John Charles Craven, hull draughtsman, Crescent Shipyard, Elizabethport, N. J.; William Leggett Gilleudeu, president and general manager, Old Dominion Steamship Company, New York, N. Y.; Gustaf M. Lagergren, hull draughtsman, New York Shipbuilding Company, Camden, N. J.; George W. Neff, eastern manager of Bierce and Smith Vaile Company, Dayton, O., 141 Broadway, New York, N. Y.; William Hackett Phillips, manager marine department, F. H. Devoe and C. T. Reynolds Company, New York, N. Y.; Herbert Bernard Saunders, marine surveyor and appraiser, 15 Whitehall street, New York, N. Y.; Edward Murray

Speakman, engine draughtsman, Fairfield Shipbuilding and Engineering Company, Glasgow, Scotland; Anson Phelps Stokes, 100 William street New York, N. Y.; George Andrew White, assistant to general manager, Hudson River Day Line, Desbrosses street pier, New York, N. Y.; Llewellyn Williams, chief engineer and acting manager, Linde Refrigerating Company, 45 Broadway, New York, N. Y.; Paul Gerhard L. Hilken, Eastern Shipbuilding Company, New London, Conn., Alexander G. Boutakoff.

Promotion from Junior to Member, 2.—Charles Barnard Page, marine and mechanical engineer, Baltimore, Md.; John Howland Gardner, assistant superintendent marine construction, New York and New Haven Railroad Company, Newport, R. I.

Promotion from Junior Membership to Associate, 1.—Edward G. Tuck, foreman in charge of mould loft and template work, Eastern Shipbuilding Co., Groton, Conn.

Juniors, 15.—Oliver Marcy Davis, engineering assistant to superintendent, Semet and Solvay Company, Ensley, Ala.; Lewis Hobart Kenney, draughtsman, office of Inspector of Machinery, U. S. N., William Cramp & Son, S. and E. B. Company, Philadelphia, Pa.; William John Norton, fitter, Chicago Shipbuilding Company, Chicago, Ill.; Horace Albert Staples, second assistant engineer, S. S. Hinon, Clyde Steamship Company; Ernst J. Thunberg, draughtsman, engineering department, Bath Iron Works, Bath, Me.; James Meriwether Winston, hull draughtsman, J. I. Thornycroft and Company, Chiswick, London; Martin C. Erismann, chief draughtsman, Marine Construction and Dry-Dock Company, Staten Island, N. Y.; Edwin A. Stevens, Jr., Daniel Bailey, Albert E. Ewen, Robert C. Simpson, William Stanke, Charles C. Moss, Robert W. Bailey, Arthur V. Curtis.

At the recommendation of the council the following officers were elected:

President, Francis T. Bowles.

Past President and Associate Member of Council, Clement A. Griscom.

Vice-Presidents, Charles H. Cramp, Frank L. Fernald, U. S. N., Philip Hichborn, U. S. N., Charles H. Loring, U. S. N., George W. Melville, U. S. N., George W. Quintard, Edwin A. Stevens, Stevenson Taylor, Robley D. Evans, U. S. N., W. L. Capps, U. S. N., Charles W. Rea, U. S. N., Frank E. Kirby.

Members and Associate Members of Council, W. Irving Babcock, James E. Denton, George W. Dickie, William F. Durand, Nat. G. Herreshoff, Ira N. Hollis, William H. Jaques, John C. Kafer, U. S. N., Frank B. King, Walter M. McFarland, Jacob W. Miller, Albert P. Niblack, U. S. N., Lewis Nixon, Cecil H. Peabody, Walter A. Post, Harrington Putnam, Horace See, E. Platt Stratton, David W. Taylor, U. S. N., George E. Weed, J. H. Linnard, U. S. N., W. D. Forbes, W. H. Brownson, U. S. N., C. R. Hanscom.

Executive Committee, Lewis Nixon, Stevenson Taylor, Edwin A. Stevens, Harrington Putnam, W. L. Capps, U. S. N., Francis T. Bowles, *ex-officio*, W. J. Baxter, U. S. N., *ex-officio*.

Secretary-Treasurer, W. J. Baxter.

President Bowles took the chair and opened the technical session.

THE CHAIRMAN: Gentlemen, I thank you heartily for the honor which you have done me. I shall have pride and pleasure in acting as your president, and I may say that I feel especially the honor of my election as the successor to Mr. Griscom, to whom this society is so deeply indebted. It has been customary for the incoming president to make an address to the society, generally directed to the prospects of the arts which we represent. I am going to suggest to you that this ad-

dress be delivered to you by the retiring president, so that next year, when we meet again, I hope to have something pleasant to say to you. The only agreeable thing about the present situation of our art is that the condition of commercial shipbuilding is so bad that it cannot get worse.

PROGRESSIVE TRIALS OF FERRYBOAT BREMEN.

BY COL. EDWIN A. STEVENS, VICE-PRESIDENT. +

ABSTRACT.

The ferryboat *Bremen* was given extensive trial in 1894, and in September, this year, when she was fitted with new propellers and her bottom thoroughly cleaned, another series of progressive trials was run. The data, which were most carefully observed and recorded, of the two series are analyzed according to Taylor's system of analysis. In the absence of single-screw trials, to use this analysis, assumptions were made for the wake factor and the propeller constant, and then the true slip of the forward screw and the efficiencies of the thrusts of both wheels were calculated. The other points determined were the skin friction and wake-making resistance, and the race augmentation. From these results the following curves were compiled for both series of trials, viz.: (1) The curves of slip and revolutions; (2) speed and revolution; (3) M.E.P. and revolutions; (4) I.H.P. and speed; (5) thrust at bow and stern; (6) the division of power and (7) wake at bow, the last three plotted to the scale of knots. A comparison is made between the trials of the *Bergen*, *Cincinnati*, and the *Bremen*.

The author states that although he is not yet prepared to accept the calculation as final, the data are presented to illustrate the method in which this analysis may be carried out. He concludes, however, that the wake of the forward screw has a definite value, varying with the speed.

DISCUSSION.

COLONEL STEVENS: Before submitting the paper to discussion, I wish to say that subsequent calculations made since the writing of this paper would lead me to revise that expression, "race augment," as used in this paper. Race augment should be taken to mean the difference in the resistance of the vessel when towed, or when driven by her own screws, and should, therefore, include thrust reduction. In other words, I believe in this shape the thrust reduction is not in any way a negligible feature. I am not prepared to submit any very detailed figures on that point now, but as far as I have gone that seems to be the conclusion pointed out, and I had not the time in the preparation of this paper—you note that the date is very close, September 20, last—I have not had time to apply these calculations to other vessels.

PROFESSOR SADLER: I think the thanks of this institution should be given to Col. Stevens for adding a little light on this somewhat vexed problem of ferry propulsion. A few months ago I had occasion to go into the question of analysis of trial trip results on ferryboats with Col. Stevens, in connection with the New York ferries—the new Staten Island ferries—and one of the first things that we had to decide upon was the dis-

tribution of power between the bow and the stern screw. The first assumption that we made was, as in the paper, that the apparent slip and the true slip of the bow screw were the same. This is not necessarily the case, as we can see from the wake curve that Col. Stevens has plotted in this paper. There are two items that seem to me to have a very important bearing upon the slip of the bow screw, and upon its performance, and those are the position of the bow screw relative to the end of the ship, and the position of the bow wave, and it seems to me quite possible in certain circumstances we may get even a negative wake at the forward end of the ship.

It may be interesting to note, in connection with the shape of the wake curve that Col. Stevens has plotted, that by an independent method I got an approximation to the variation in the wake, and I think in my curve the numerical values were different from Col. Stevens'. The general character of the wake curve was the same, that is, it started to rise at the lower speeds, then remained either normal or very nearly constant, then rose again to the highest speeds, and showed a falling off at the end, I think showing that the character of the wake curve, as shown in the paper, is approximately correct, as near as I can make out.

Some criticism may be raised as to choosing a wake factor value of .12 for the after screw, that factor being obtained from the single-screw trials of similar vessels. There is no doubt that the race of that forward screw will somewhat affect the race at the after screw. It also tends to increase naturally the difference between the thrust and loss deductions of wake gain. But, on the whole, I think Col. Stevens is perfectly right in crediting all that loss to what he calls this "race augment or resistance," because the bow screw is the direct cause of that increase in resistance. When it is noticed, as in the paper, that the difference in efficiencies for two practically similar vessels varies as much as from ten to fifteen per cent., I think the need of careful analysis, such as we have in this paper, is immediately apparent.

PROFESSOR PEABODY: I hope Col. Stevens will find it possible to add an appendix, if necessary, or additional data which he says he now has in hand, and that it will give a material gain to the society, especially as adding to so important a piece of work as all such trials must be.

MR. NEWMAN: I would like to hear from Mr. Stevens as to what he thinks of the future development of the turbine in boats of this character. It looks to me as if it was particularly adapted to those purposes.

MR. TAYLOR: I was glad to hear Col. Stevens explain in this paper that the race augment, as used by him, was intended to include both the thrust reduction and the active resistance of the rise of the forward screw, because it seems to me that he assumes the efficiency of one, in other words that he assumes that the thrust reduction is neutralized by the gain from the wake, and as he has a wake of twelve per cent. he must necessarily have a thrust reduction of about twelve per cent. of the thrust of the rear screw. Even that, however, leaves a very large race augment to be accounted for. A race augment that he gives at eleven knots for the *Bergen* is 209 horse power, and referring to the curve of I. H. P. at eleven knots, it would seem that an increase from eleven to twelve knots requires somewhere in the neighborhood of 300 or perhaps a little over 300 horse power.

I should say the rate of increase at eleven knots is a little over 300 horse power. In other words, it would seem as if the race augment were equivalent to holding back the ship from one-half to three-quarters of a knot in still water. It seems that Col. Stevens has run across a puzzle in these trials which is very apt to be the case in analysis trials. The trial in 1894 and the trial of 1903 practically differ only in the screws used. In the trial of 1894 the screw was a good deal smaller than the screw used in the trial of 1903, and referring to the curve of I. H. P. in speed at about eleven knots, the curve of 1894 crosses the curve of 1903 and proceeds to rise every mile very rapidly, the slip increasing very fast. Looking at that curve, and looking at the outlines of the propellers, the natural inference, of course, would be that the propeller of 1894 was too small, and that it showed signs of what since then we have learned to call cavitation. But when we look at the curves of the slip we see that the 1894 curve of slip is actually less than the 1903 curve of slip, until we reach a speed a little over eleven knots. The only reasonable accounting for this is that the pitch of the 1894 screw was too small as given—the pitch was not known. That is one of the puzzles we are very apt to run across in these experimental results, but there is a remarkable difference in the speed given by these two screws, and something we can scarcely account for on any present theory so far as I know of screw action.

MR. STEVENS: I would say, as to the wake values, there can be absolutely no question but that the wake for the forward screw will affect the value of the wake at the after screw. Professor Denton some years ago on investigation of these very trials—1894 trials of the *Bergen*—estimated that the wakes delivered by the forward screw would come to a rest if considered as a column of water projected into a large body of water, would come to a rest at a distance of about 50 feet aft the screw. In other words, the water 50 feet aft the screw would be very nearly in the condition as normal as at the stem, so that it would amount to deducting 50 feet in the length of the vessel as far as creating a wake is concerned. The effect of that seems to be very difficult to estimate. We have single screw trials of three vessels, the *Bergen*, the *Cincinnati*, and the *Edgewater*. The first two are about 200 feet in length, the *Edgewater* about 170. The breakwater efficiency of the boats is practically the same, and at the same time the wake works out very nearly the same in all three vessels. The maximum value, as I recall it now, is .126, and the minimum is .117. As to the A values, they will plot remarkably low. The lowest is .375 for the after screw, and for the *Floyd's* trial screw the value is somewhere over .70.

As to turbines, that matter has been pretty carefully considered. The difficulty lies in this, that the efficiency of propulsion seems to depend a great deal on the slip. Of course these boats all seem to improve where it is possible to give them a long trial. Inclination of the propeller shaft is impossible in this type. It restricts the diameter of the wheel unless excessive draft is taken, which involves an increase of wetted surface and other drawbacks, and also a loss of stability in the vessel itself, which becomes of importance. In considering the stability of a ferryboat, you must remember it is not any

question of upsetting or a dangerous heel, and there is a crowding on these boats that would not be permitted on any other boats; that means an incline or tip of about fifteen degrees. With a ferryboat crowded with a lot of passengers that heel creates a panic. Therefore the stability has to be very carefully considered.

With the turbine, it seems to be that not enough is known as to the proper propellers to use to settle the question. The available data are not of the most satisfactory character as to that question, and at present it seems to involve the use of small propellers of very fine pitch, running with considerable slip, and that, in anyone's judgment who has considered it with relation to the ferryboat problem, has been enough to condemn the type. There is another question here which makes the turbine particularly ill adapted to ferry service, and that is the requirement of running in both directions. It means, in order to secure the efficiency, a practical duplication of the driver, so that the saving in weight is almost done away with.

As to Constructor Taylor's remark, it is perfectly apparent to anyone familiar with the system for the analysis of trial results, that it is impossible with complications introduced by the forward screw, to get the actual hull resistance. You have to estimate that for the purpose of the test. The object of it is to divide the power delivered to the shaft between the screws and to determine as far as possible the efficiency of each of those screws. In other words, determining how the thrust is exerted, as bearing out, to a certain extent, the idea that I have just mentioned, that the decrease in slip is to avoid the injurious action of the race augment proper—that is, the resistance due to the race from the forward screw. That race augment is, of course, due to the water thrown back by the forward screw. Now, the two vessels which have shown the highest propulsive efficiency of which I have data, have been the *Newark*, of the Pennsylvania Railroad, and the *Edgewater*, of the Fort Lee ferry. On these two boats, from different causes, the forward screw is worked at a disadvantage. Both boats have rounded backs to the blades—in other words, the blades are shaped like the blades to an ordinary vessel. In the *Newark* the blade is of a modified type with general lift of a rather large surface, and the generatrix is inclined aft and curved. I have no exact data as to the differences between the two screws. I have just got the pitch given generally. I will give the effect of that afterward. As far as I have been able to analyze in the trials, using practically the same system as Lamont's, but with probably more assumptions, and, therefore, with less accuracy than is possible in this case, the *Newark* showed unquestionably a high propulsive efficiency. In the case of the *Edgewater*, by one of those contrary circumstances which happen, the pitch of the forward screws turned out to be less than the pitch of the after screws, the difference being about two inches in ten feet of pitch. In the *Edgewater* the difference between the single-screw trials and the two-screw trials is comparatively small, and plotting out (if we take that difference, merely considering that difference between the two trials) the space between the two curves, and attempt to account for that, we have two items to charge to it: one is the propeller losses due to the forward screw—the ordinary propeller losses—and the other this

race augment. Therefore, applying the same system used herein, with the A value determined, the W value (the value of the wake for the single-screw aft) is determined by the trials, and the fair value of A can be determined from the forward screw. That seems to work out between seven- and eight-tenths of the value of the aft. Of course, it is possible in the forward screw single trial to get the $A.W.$ diagram. You can't get the intersectional curves, you cannot get loops for them, but the limits between which you can work with all the assumptions I have been enabled to make, seems to indicate a value somewhere between seven- and eight-tenths with the rounded backs of the other one that I have assumed in the trials of the *Edgewater*; in that case, as I say, it was a mere strip of the space under the I. H. P. curve. The result seems to point to the fact, as Prof. Sadler would say, the position of the screw in relation to—well, we will call it to the shape of the bow—practically is of very great importance. That is to say, those boats that seem to have the screw forced away from the body of the vessel, taking into consideration the other elements which would affect their efficiency, seem to show the best results; that is to say, as the screw gets nearer the end of the water line it seems somehow or other to offer less impediment to the vessel's progress.

MR. WHEELER: I would like to ask the Colonel if the correctness of the steam gauges and the vacuum gauges were verified. I noticed in the trial of the *Bremen* that the vacuum ranged very high, in over half the trial 28 inches, while in some cases it is 28.8. It occurs to me it requires a little correction there.

MR. STEVENS: The vacuum gauges had been verified about six weeks before the trial, but the springs on the indicators were tested and gave a little over an inch less of the vacuum than that shown.

MR. WHEELER: I think that is doing very well, to have only one inch less in the cylinders.

THE CHAIRMAN: Gentlemen, if no further remarks, the Chair observes from the discussion that, while this discussion seems to deepen the mystery that surrounds the action of screw propellers, it is undoubtedly of value in the way of engineering data as the continuation of the trials of ferryboats which Col. Stevens' liberality and great interest has laid before us. The Chair hopes that it will fall to the lot of some member of this society to ultimately investigate thoroughly the action of screw propellers. The Chair feels confident that this will be the case.

We will now proceed to the next paper. The Isthmian Canal seems to be settled, and so the second paper has been withdrawn.

NOTES ON THE ARRANGEMENT AND CONSTRUCTION OF STEAM PIPES AND THEIR CONNECTIONS.

BY ROBERT C. MONTEAGLE, MEMBER.

ABSTRACT.

As stated by the author, the principal object of the paper is, first, to point out and emphasize some of the causes of failure of steam pipes; and, second, to describe some points to be observed in design and material. The causes of failure in steam piping are, first, faulty design; second, bad workmanship; and, third, de-

fective material. Under the first head the employment of copper for high pressures is considered to be a mistake, as its elastic limit is only about 5,400 pounds per square inch; steel should be used, as its elastic limit is over 30,000 pounds. Copper is always more or less injured in the neighborhood of brazing, and all large-sized copper pipes are made up sectionally. Illustrations are given of some common methods employed for taking up expansion, which are of most faulty design. During the manufacture and erection of pipe sufficient care is not observed to insure against defective material and workmanship, and the author strongly urges the general adoption of severe tests for specimen pieces of all piping. This test should be repeated, as often latent defects do not develop until pressure has been applied two or three times.

An illustration is given of an expansion joint properly designed to take care of all expansion and at the same time not subject the piping to any undue strains or twists. Then are given specifications for copper, seamless steel, and lap-welded steel steam pipes laid down by the Bureau of Steam Engineering, covering the inspection and testing of all classes of steam piping.

DISCUSSION.

MR. FORBES: Mr. Chairman, a year ago I wrote a paper which I intended to lay before this association, but after having written it and putting it aside, I read it over and it put me in mind of the pudding that we used to have at school—too much dough and not enough plums—so I threw it away and saved the society the agony. But this paper gives me an opportunity to offer the plums, if you may so call them, in a few words. I had hoped that I was the inventor of the idea which I first wished to suggest, but afterwards, meeting Mr. Meyers Corriel, I found I was not the originator at all, but that Mr. Bellville was the originator of the idea, that he believed that his system, which I thought was mine, coupled with a certain kind of fish oil, produced a tight joint in a fire. And that, gentlemen, is simply this, and I found it accidentally, that if you will take the ordinary American fittings, say of an inch to two inches of 11 1-2 threads, and take your flange as 11 threads, you can make a perfectly tight joint with almost no difficulty whatever. That is Mr. Bellville's idea. I think if you will adopt that you will in many cases overcome difficulties and save yourself trouble. That is for the thread. Now, when you come to the flanges, I have found great difficulty under high pressures of keeping the flanges from blowing out, and I adopted some years ago a method which is absolutely satisfactory. All I did was to dish those flanges—that is to say, to make them so that when the packing was drawn together it was drawn together more closely on the outside of the flange than on the inner side. The result was that you had a wedge-shaped form into which the packing was driven by the pressure, and it kept it perfectly tight.

Of course, there are a great many jim-cracks we get up. One of them I have here, which I want to show you, and I want to say there is no patent on this, and if anyone wishes to look into it he is most welcome. I found that in ship work, in piping, there was always some sort of angle or twist that they did not make any fitting for, so I got up this little apparatus, and there again my pride had an awful fall, because I found a man

had gotten up a better one long before me, but no one used it, but there it is. You have simply a straight run which can be used as a union, by just turning you have an elbow. Now, of course, you can get any position from the straight run with this joint pointing in any direction, until you have anything from a straight run to forty-five degrees. That has been very useful to me. The objection to it is, of course, you have a bolt through there which will gradually deteriorate, but the rival got over that by putting a union nut on the outside, which is very much better, but it isn't in the market and I don't think it can be obtained.

MR. LOVEKIN: It has been my pleasure during the last four years to have done a great amount of experimenting with, inventing, and perfecting a system of pipe expanding and flanging machinery and tools, which are about ready to be placed on the market. These machines and tools embody all sizes and classes of expanding, flaring, and beading tools, also tube cutters. We are making at present a machine which will expand and bead or flange piping 24 inches in diameter 20 feet long. This machine weighs 20 tons, and the tools alone will weigh over one ton. I have successfully demonstrated the practicability of all these machines and tools with tests which I am about to submit to you given by me in a lecture before the Franklin Institute on this subject October 20, 1903. I gave a full description of the machines and tools in actual operation, together with numerous samples of work exhibited. The interest shown at this meeting was such that I made further tests from samples of 2 1-2-inch seamless-drawn tubing with United States Navy standard steel flanges. I had intended using the regular dudgeon-pipe expander on two of these samples so as to test the difference between the joint made with the old-style expander and those made with my new types. Owing to the short space of time, however, I was compelled to give up the idea, and made all joints with my tools.

I believe these joints will, in every case, stand the same test as any welded steel flange, inasmuch as the shearing value of the grooves can be made such as to cause failure of the pipe itself before leaking. I can also state positively that, with my machine and tools, we can make a joint that will stand fully double the test pressure of other joints made with any known expander. This is due to the construction of the tool, it having an immense advantage in the feeding mechanism which consists of a hand wheel the inside of which forms a nut which comes in contact with a threaded pin passing through the mandril. Thus we have the circumference of hand wheel divided by the pitch of thread for power applied to advance mandril, minus friction. The mandril is freely revolving instead of a fixed mandril, thereby all torsional strains are removed. In my case outside are a couple of samples which I brought this morning from Philadelphia, and I have the subject matter here of several tests which I will be glad to read, and also give to the society, which verify Mr. Montague's statement very much.

Here follows a report made by the Quinby Engineering Company, Philadelphia, at their laboratory on November 9, on samples of pipe. The first one was a No. 10 B.W.G. 4-inch inside diameter steel tube expanded into cast-iron flanges on each end, 2 1-2 inches

thick, each end being covered with cast-iron blank flanges of 6 inches held by four 1 3-4-inch bolts. A standard 1-8-inch gas-pipe connection was tapped into one end for applying hydrostatic pressure. At a pressure of 3,800 pounds per square inch the flange opened and packing blew out, showing that heavier bolts must be used.

The second test was made on a brazed copper pipe of 4-inches diameter and 5-32-inch thick, each end being hammered and brazed into composition flanges 1 5-8 inches thick, otherwise being the same as in test 1. The pipe burst at 1,900 pounds per square inch. At the brazing the elongation was 3-8 inch. The pipe also bulged near the flanges.

The third test was made on a solid copper pipe of same size as No. 2, the ends being flared 20 degrees, and each was expanded into three grooves 1-8 inch wide and about 1-64 inch deep in 2 1-2-inch cast-iron flanges; otherwise conditions were the same as previous. A slight elongation was noted up to a pressure of 3,400 pounds when the flanges slipped on the tube 5-16 inch with a jump shearing the ridges off. On applying pressure up to 400 pounds a second time, there was absolutely no leak. According to the United States Navy formula the comparative strength of brazed and non-brazed pipes is as 4.4 to 1. Other tests are reported on steel pipes, expanded and flanged in the machines designed by the speaker are given, and in conclusion he states as follows:

On previous tests that I made with brazed pipes and pipes not brazed, in every case where I could get a pull such as I did without any internal pressure by applying the hydraulic jack on the inside with a blank flange at the bottom, putting a plunger in so as to get an end pull, the brazed pipe was in every case about twenty per cent. weaker than the pipe simply expanded, and when it came to the bursting test the pipe not brazed was 4.4 times stronger than the brazed pipe.

MR. NEWMAN: Mr. Lovekin's experiment on the expanding machine is very interesting and shows practical skill in its development, but I think we should approach the use of an expanded tube in a steam pipe very cautiously for this reason: We can expand a tube into a flange for water, air, or low pressures, but a pipe under the pressure of steam or temperature where it expands and contracts, would tend to loosen the flange from the pipes. These tests, of course, are only tests under hydraulic pressure. If they were applied with steam I think perhaps the result would be that the flange would loosen constantly. I think we can't do better than to follow facts.

GASOLINE ENGINES FOR MARINE PROPULSION.

BY D. H. COX, MEMBER.

ABSTRACT.

This paper first deals in a most elemental style with the functions of gas engines, stating the method of starting and controlling the engine, describing the difference between the double and four-cycle type and other features. Then follows detailed description of two of the largest types of gas engines yet installed in boats, the *Standard* and the *Adios*, the two fast-speed

launches which appeared this year. The general dimensions of both boats are given, and an extended description of the construction of the *Standard* follows. Designs of these and two other freak-type boats, and photographs taken of them at full speed, are presented. The author believes that from the success attained with many of these designs of small types the government would be warranted in getting out similar lines for torpedo boats.

DISCUSSION.

Mr. COX: I might have stated a little more clearly that it is very difficult indeed to arrive at any conclusions whatsoever in the performance of launches when you only have the reading given by the manufacturer, because, for various reasons, some manufacturers underestimate and others overestimate the output of their engines of given size, and it is very difficult indeed in the small engines used, the expense hardly warrants taking indicators. You take, for instance, a 6-cylinder, 100-horse-power engine, although the cylinders are all alike, it would not by any means be safe to assume each cylinder was doing the same amount of work, and that by indicating one you could arrive at the total horse power by simply multiplying by the number of units, and unless some more reliable method, or more care is taken in the rating of engines, it is rather hard to arrive at any conclusions. Then, again, I would state that the speeds I have given, as mentioned in this paper, I don't wish in any sense to be responsible for, as I was not present at any of the trials, except possibly the *Standard*, which I can state from personal experience has run about the speed I have mentioned.

Mr. SADLER: I would like to ask Mr. Cox as to the amount of gasoline used on the different types of engines. I think that information would be very valuable, and is very hard to get.

Mr. COX: I would say I haven't had any opportunity to make any experiments of that sort, but I am convinced from inquiry among a number of people who would have no object to state anything that was not correct, that for a launch of a given horse power, and a given tank, a pint per horse power isn't very far off. But there are a good many reasons that affect that. Some makers have an arrangement by which they can draw the air supply from a heated source. That has a very considerable effect on the consumption for some reason. Of course in winter weather it is the practice of a great many manufacturers to draw the air supply from a heated source, but even in summer, when the temperature of the air is warm, some people further warm it by jackets around the pipe, and that has a considerable effect on the consumption of gasoline. And under those conditions, although you will not get as much horse power out of an engine, the consumption is less, but that has not been looked into as much as it should.

Mr. STEVENS: I think that this paper is very timely just now, because we are at the beginning of a new era in launches. There is no question of that. Within the past two or three years there has been a very marked development in the use of the gasoline motor or the explosion motor. It has found its way into auxiliary yachts formerly sailing vessels; and also into the smaller types of fishing boats, even the oyster skiffs, and

small surface boats of the fishermen, and also small boats used in the commercial service. Just now we are tending toward a development on the lines of the French type. I think it should be stated here very plainly that the launch is practically an American institution in its use. The furthest back I can trace the history of any launches is to the work of our esteemed member, Mr. Haswell, whom I think produced a steam launch in 1857, but the modern power launch, as it is called, is an American institution. It is more numerous in this country and more fully developed to-day. The first power launches we had was about twenty years ago when the naphtha launch, driven by a small steam engine using naphtha as fuel and using the vapor in the engines, came into use. Following that the explosive motor of the Daimler type came in about fifteen years ago, and while both the automobile and the launch came from a common source, our development of launches has preceded that of the automobile, for during this period of fifteen years they have produced in this country a very large number of launches, many of them very roughly built, not very refined engineering, the two-cycle in the smaller sizes, and the four in the larger, and these have gone into all sorts of boats and have given very excellent service, of course with some local defects. Within two or three years the French have pushed the launch question to a very high point of perfection as far as speed goes, but this work has been done by the French automobile makers and yachtsmen. They have used the light automobile engines for launches intended for speed, of very slight construction and design. There has been formed in France in the last few years the Helice Club, devoted exclusively to launch racing. In the past year there has been a great deal of work done with launches in France; there have been two races of 100 kilometers, endurance runs, and also a race from Paris to the sea. England has been behind us in the launch races. They have used for yacht tenders or similar boats the paraffin motors, distinctly inferior to the American gasoline motor as used here for years past, but in the last few years there has been a furore in England for the American type of gasoline motor, and a great many are now imported into England.

One English race has already been held in connection with the Harmsworth cup, the winning boat being built by Mr. Napier, designed by Mr. Edde, and carrying a strictly automobile engine, used in Mr. Edde's automobile in his Paris-Berlin race two years ago. The Thornycrofts have also taken up the gasoline launch with some activity. It promises to be an interesting season next year in England, and also in France, with international races in these automobile launches as they may be strictly called. An exposition of gasoline launches is to take place next year at Monaco, in France, and will be supplemented by racing, to which only the boats shown in the exposition will be eligible. There will be some prizes for motors using petroleum, and of each prize ten per cent. goes to the builder of the hull and ten per cent. to the builder of the motor out of the total prize to go to the boat. This question of international races suggests a necessity for international rules in which this country shall participate. Within the past four years we have formed in New York a national motor boat association which has done something to

secure uniformity in the timing of races and in the rating of boats and motors. It has made quite an appreciable start and we may anticipate considerable progress in the near future, as many engineers are at present interested in it.

The launches we have had in this country up to the past year are not properly speed launches in that there has been no attempt to over refine the weight of engines. They are practically service launches, intended for general use.

I have some data here concerning Mr. Leighton's boat *Zaza* which was given me by the owner. The boat is 35 feet over all, 5 feet 4 inches breadth extreme, 5 feet breadth on the water line, and about 10 inches draft. She is copper built and rather heavy; the planking is 3-4 inch below the water and 5-8 above; the frames 3-4 by 1 1-4 inches spaced 9 inches, and by a curious process laid flat and not on edge. The bilge keelsons which carry the engine are 25 feet long, 14 inches deep in the middle, and 1 1-2 inches thick. The motor originally was a 6 by 5 Leighton, three cylinders. This year a fourth cylinder was added by an extension of the bed plate, and it has been run through the season, making about 650 turns, at its best. The weight of the present motor is about 950 pounds, for about 25 horse power, and 1,200 pounds with multipliers, etc. The screw is 22 inches in diameter, 28 pitch, three blades.

From numerous timed runs the boat is accredited a speed of 18 miles, which is doing excellent work for her type, which is not a true speed launch but the regular service type.

On the engine of the *Pink* a small port is cut in the compression chamber in the base, which is uncovered on the upstroke of the piston, and takes in a very small charge of free air. This seems to give twenty to thirty thrusts more per minute with a little increase in the consumption of gasoline.

There is one other important question in connection with these motors which are really more than gasoline motors, and that is fuel. The demand for gasoline for these boats is increasing very fast and it is a question what other fuels are available. In France for about three years past, through the Department of Agriculture, very strong efforts have been made to promote the production of alcohol by small farmers. The French government has given prizes for all kinds of apparatus for using *alcohol de natura*, or debased alcohol as it is called not fit for consumption, for lighting, and heating apparatus. In nearly every race that is run there is at least one supplemental prize for those using alcohol in place of gasoline, and as this alcohol can be made from almost any ordinary farm product, it promises to play an important part in the development of the explosive motor in France and Germany. Thus far we are only using gasoline here.

THE CHAIRMAN: Commander de Faraman, of the French Navy, who is with us this morning, has kindly consented to give us some information which will be appended to the discussion.

MR. STRATTON: I would like to make a few remarks in contribution to the history of this matter. I believe that Mr. Charles Haswell has the honor of having built the first miniature steam boat in this country which may be styled a launch and which is a side-wheel boat, I believe. The second boat as a miniature steamboat

was built by the Collins Steamship Company and used on Flushing bay about 1859 or 1860, to experiment in the various kinds of rotary paddle wheels. The boat was built by the Novelty Iron Works, and the entire summer was devoted in the use of this boat in various experiments. The first steam launch that I know of existing in this harbor was brought out by Mr. Jacob Lorillard, who introduced the Root square rotary engine and square piston, and I think that was in 1860, and to him belongs the honor of having first developed successful steam launches in this country.

MR. LUCAS: I wish to draw your attention to the fact that this class of boats has a very shallow draft and rather a high free board, and it appears to me that there is a great possibility for increased speed by immersing them deeper and having less free board, retaining simply the same hull and the same hull weights, and giving the additional amount of displacement entirely to machinery and increased amount of fuel. These boats are built for smooth water, and therefore do not need the excessive free board that most of them show, and I believe most of them will have the necessary strength for these smooth-water conditions that they could stand an additional amount of immersion. Another feature which is very important in connection with this style of boat, which are pretty nearly all of the flat-stern torpedo-boat type, is that their stern ought not to be immersed in the water; their knuckles should be at the water line and not in the water. I think this brings with it a necessity for a very close calculation of the weights in the longitudinal position to determine the trim of the boat. All additional immersion ought to come in such a manner that the water lines should radiate out from the sharp knuckle at the stern, and should not be parallel with each other as they are in the *Noma* to-day.

MR. CRANE: There is one point which has not been called attention to, and that is very interesting, about gasoline-engine development, that is the extremely light weight per horse power. The lightest torpedo-boat machinery weighs 35 pounds per indicated horse power, that including boilers and necessary auxiliaries. Engines of a larger size have been built that weighed 16 pounds per brake horse power. With the weight of machinery reduced to 16 pounds per indicated horse power at once there comes the possibility of greater speed in a self-propelled boat than we have ever had before by increasing our power on the same displacement or by decreasing the displacement. The light draft of almost all the boats shown in the sketches is due to the extreme lightness of the machinery, and the surprise is that more than forty or fifty or one hundred horse power is placed in boats of the smaller dimensions.

MR. FERGUSON: I don't think that will apply to boats when you get to any size. Take a boat up to say the size of the *Arrow*, about 75 tons perhaps, now her machinery gets down to about 17 pounds to the horse power, including the auxiliary machinery, electric-lighting machinery, and everything that goes with it, water in the boilers. Now, as soon as you get a gas engine of any horse power, that is of such horse power with a multiplication of cylinders, a small engine won't answer the purpose. You immediately get enormous weights, more weights than a steam plant of the same horse power, and while for small launches you can perhaps get a speed up by a multiplication of cylinders, it would be possible to ob-

tain a speed of 30 to 32 knots, still I don't think it would ever be possible unless the lines of the engines are very much improved, by which you could obtain anything like the speed you get out of a steam vessel, say 35 or 40 knots, which is possible. So it would seem that the gasoline motor for fast boats would be confined to small boats where you use quite a number of small cylinders, but not for a boat requiring sufficient power to have an ordinary good-sized cylinder.

I would like to recommend to those members of the society who have these trials in charge, that they make official records that one could rely upon. I notice in going over all these boats and trying to find out what they have done, we get all sorts of unreliable reports. Of course I understand most of this is done for commercial purposes, but I think sooner or later this class of boat is bound to be taken up by people who have heretofore dealt with steamers, and that they will begin to realize the importance of getting some reliable results on record, and I think we would do more toward the advancement of the gas boat than perhaps any other thing that could be done at the present time.

I have often been asked where the distinction lay between a launch and a yacht, and have always been unable to answer it, except on the hypothesis that in the old navy we used to have a boat on a fair boom which was called a launch and which I think was 27 feet in length. That was called a launch, as I understand it, because they had to launch it; it wasn't carried at the davits, it was launched from the vessel, and when steam was put into that boat it still retained the name of launch. Why a boat that is 75 feet long, without any cabin on it, should be called a launch I can't comprehend. The mere fact of putting a cabin on to a boat 30 feet long seems to change it from a launch to a yacht in the estimation of the public. If anybody can give me any information on that point as to where a launch ends and a yacht commences I should be very glad to know.

MR. COX: The economy of running a launch, on basis of the consumption per horse power and the price of the two fuels, makes the gasoline vessels show up very badly, but there are other facts to be taken into consideration. That is to say, with the use of gasoline the force required to handle the boat is considerably less. With 200 or more horse power one man can take care of the engine, and then again with the gasoline there is no question of ever banking the fires or making fires. If you want a fire you go down and start it or try to start it, as the case may be. But you don't have to get up steam pressure, nor to waste coal in doing so.

SECOND SESSION.

The President called the meeting to order and the following papers were taken up:

SOME THOUGHTS ON THE DESIGN OF MODERN STEAM YACHTS.

BY CLINTON H. CRANE, ASSOCIATE.

ABSTRACT.

One scarcely realizes the rapid growth in our steam yacht fleet as revealed by the register of yachts, which shows 433 steam yachts of American ownership with a total of nearly 60,000 gross tons. Half of this tonnage has been built since 1890, and thirty-three, of about a

third of the tonnage, are of English design and build. One hundred and eight of these vessels, of about 47,000 gross tons, are over 120 feet water line length. The yachts are classed under two general headings of ferryboat, for taking the owner from his country place to the city, and cruisers. The appearance of the English yacht among our fleets has stimulated American designers to produce vessels of better sea-going qualities and of improved outside appearance. On the other hand, American yachts have as a rule been faster boats, and, in regard to ventilation and plumbing, are much superior to the English yacht. At the same time we have been able to obtain a higher speed without increasing weight or space taken up by machinery, for in the American boat the water-tube boiler is quite generally used, while the English one is equipped with Scotch boilers. A speed curve is drawn which the author commented on in the discussion below.

The influence of the registration societies in requiring strong construction has been to develop a splendid class of vessels. The remaining page of this paper describes the steam yacht *Noma*, which is 252 feet over all and 226 feet on the water line. Her speed on trial was over 19 knots. Twenty-two per cent. of her displacement of 1,035 tons is devoted to the machinery. A full set of drawings of the *Noma* is added.

DISCUSSION.

MR. CRANE: I should like to say in explanation of this typical yacht-speed curve that it is drawn with a speed equal to the square root of the vessel's length taken as a unit and the power required for this speed as one hundred, that no exact figures are required or supposed to be given by the curve. The curve merely shows the general rate of increase of power of a vessel of yacht form, and the way the various vessels are placed on the curve shows the relation of their speed to the square roots of their length; that is, a boat whose length is 100 feet and whose speed was 11 knots would be at a point on the curve at 11-10 on the base measurement. I should like to further add that the speeds given in this table are the best authentic speeds in the knowledge of the writer. Many of these boats may have exceeded these speeds, but I know they have attained as high as the speeds given.

MR. SADLER: There are some rather interesting points in this paper raised by Mr. Crane. The design and construction of large steam yachts or steam yachts of any kind always seems to me to be more or less of an experimental nature for the other branches of this profession. There has no doubt been a good deal of work done in steam yacht construction in getting people to use water-tube boilers. I think with the exception of the navy and steam yacht work you may say that practically the water-tube boiler has not been looked upon with much favor in the merchant marine.

Those of us who have had to deal with the strength of vessels of this character know very well that Lloyd's requirements are amply sufficient for any service that the vessel is likely to encounter. In fact, personally, I think that the scantlings as required by Lloyd's could be considerably reduced, basing the calculations on the results of certain channel steamers that run across from England to France, which are built according to the Board of Trade. Those scantlings are very much less

than the corresponding scantlings of the vessels of the same size of the yacht type, and they have to do pretty much the same service; that is, carrying practically no cargo, simply coal and passengers. So I think with the steam yacht we might make still further advance in the way of speed by the reduction of weight in scantlings. And there is one other point about the general shape of these vessels. We know that when we get into vessels of this size, the size of the *Noma*, say from 220 feet, that the form that is most easily driven at that rate of speed is one of rather full amidship section and fine ends. The original shape of the amidship section of the steam yacht developed from the sailing yacht, and it seems to me that when we are aiming at speed and are going to use steam as our method of propulsion, there is no reason why we should not adopt the best form that is used in other lines of steam propulsion, and not necessarily the yacht form. I think myself that a higher speed could be obtained on vessels of this dimension by a modification of form, especially in the amidship section and in the after ends of the vessel. I am glad to hear of Mr. Crane's surprise at the tightness of screw joints in boilers of this type, which seems to be a regular boggy to most engineers.

MR. STEVENS: Mr. Chairman, the question of form of yachts having been raised, I would like to ask some of the yacht designers here the reason for the peculiar formation of the ends which have become typical of our steam yachts. The bow always struck me as the remainder of the clipper ship and sailing frigate type, in which it was necessary to support a long bowsprit on account of the enormous head sail. The steam yacht seems to be carrying a bowsprit, and it seems to me to be absolutely useless and an expenditure of weight, carrying that form there, and it always struck me in looking at it as unnecessary. The same applies to the stern. It seems to me to be a copy of the old plank on edge type of the old English cutter, in which it was necessary to provide practically an outrigger to hand in your boom, and I suppose the stern is carried out on deck to provide room for the average Englishman's foot.

It has always struck me that the two ends of the vessel represented an expenditure of weight and an expenditure of bulk at places where they were of very little assistance to the ship. That is to say, if they could incorporate the same amount of weight and bulk in the body of the ship I think it would be of greater advantage. I never tried to design a steam yacht, and, therefore, I put these suggestions mainly in the form of questions and not as criticisms, and also to see whether, as matter of fact, these forms are not forced mainly by the requirements of owners on the supposition that they impart beauty to the form. To my eye, a well-proportioned, well-designed, modern cruiser is as beautiful, if not more beautiful, than the yacht.

MR. PACKARD: I was very much interested in Mr. Stevens' colloquy because we have had several cases where owners have forced us to build long ends. The main argument for the overhang bow and stern is in the first place more deck room, and, second, in a sea way the greater length is a decided advantage—it makes the boat decidedly easier in the sea, dryer, and on that account it is an advantage, and on the other hand for a high-speed boat there is no question but that much

shorter ends, very much on the type of the cruiser, would be of a decided advantage. We have tried to persuade two or three owners, however, to have ends of that kind, and they have utterly refused when they saw a boat like the *Corsair* and the *Noma* or any of those large boats.

THE CHAIRMAN: In view of the large number of water-tube boilers fitted on our yachts I would think we might hear something more on the water-tube boiler question. If we cannot start a controversy about water-tube boilers I should like to call the attention of the society to the statement of Mr. Crane that the *Noma* is fitted with large bilge keels, which apparently do not interfere with her speed. I believe that is a matter as to which there is a great deal of difference of opinion. I recall in the case of two torpedo-boat destroyers which were recently built, the contractors were very much prejudiced against bilge keels, boats built on their own lines, and one of the requirements by the department before they were given the contract was to put in bilge keels. They objected to that very much, thinking that would interfere with the speed. It so happened that finally two boats, just alike, were tried, one with bilge keels and one without. The one with bilge keels, if I am not mistaken, did a shade the best, but it was thought that there was some other reason for it. The facts in the case apparently being that the bilge keels had no appreciable effect.

We have made some experiments in the model basin with 20-foot models built with bilge keels and without; so far as our experiments go they would indicate that the additional resistance of the bilge keels; if they are properly fitted—we haven't tried yet any improperly fitted—was never greater than the additional wetted surface. Of course if you fit a bilge keel so that the water does not come fairly at it you are likely to get an eddy behind it and increased resistance, but the bilge keel on a fair line apparently does not increase the difference. There are great differences of opinion on that subject, I believe, among naval architects.

With reference to Prof. Sadler's discussion on the fullness of the amidship section of these boats, I expect you will find that these boats have a very fine block coefficient, and the prismatic coefficient of the *Noma* is given as .601. Her block coefficient was probably in the neighborhood of .45 or .48.

MR. CRANE: It was never figured.

MR. PACKARD: You will find that such a low block coefficient if you give the amidship section the whole of the displacement, the displacement will be concentrated amidships, and it is very difficult to get any sort of lines on the ends. I think that Prof. Sadler is right in saying that full amidship sections associated with fine ends are quite fast, certainly in smooth water. That can't be carried too far, however, because if you push the speed up beyond a certain limit you find that the fine ends are objectionable. We have tested a number of models with fine ends and full ends in connection with the proposed 1,200-ton type of boat, which was to make 24 or 25 knots. But it so happened that at about 24 knots, with this length which was 280 feet, there was not very much difference between the fine ends and the full ends, but above that, the speed for the full ends was much lowered. Below that speed the fine-ended models drove easily. I think the reason for that is simply that with

very fine ends as soon as you get up to a very high speed, why the whole bulk of your boat is affecting the resistance and you lose the result of the fine ends. In the full ends you get the advantage of the whole length of your boat in pushing the water out of the way. At those very high rates of speed it is not so much a question of fine lines as brute force, pushing the water—that is, of course, 22 knots on a length of 280 feet, which is quite a bit above the speed of the *Noma*.

MR. ROBERTS: Mr. Chairman, I rise to respond to your inquiry as to why water-tube boiler men don't have something more to say in regard to this matter. I think there is a very good reason for it. The fact that to my belief at least 90 per cent. of the steam yachts in the United States are fitted with water-tube boilers, and that at least 90 per cent. of these water-tube boilers have screw joints, speaks for itself.

MR. CRANE: The shape of the modern yacht amidship section I think is unquestionably of no advantage to her in smooth water, but I do think that a sharp section makes a boat faster and easier in a sea, and I think it is for that reason that yachtsmen have held to the sharp section of their steam yachts, for yachts as a rule are small vessels, and for their size they encounter larger seas more frequently than other ships.

In regard to the bow and stern, as Mr. Stevens imagines, it is entirely a matter of style. It is a question of the public taste of the yachtsman. If style required a straight or a ram bow and a short stern the yachtsman would have it. There is no question at all that it has come down from the old-fashioned clipper shape. As far as the stern goes it has a certain advantage in itself in that it gives a larger quarter deck and that is a thing which many owners wish.

WATERTIGHT SUBDIVISION OF WARSHIPS.

BY WILLIAM HOVCAARD, COMMANDER ROYAL DANISH NAVY, MEMBER.

ABSTRACT.

The author first points out that the safety of a ship is dependent primarily on two factors: buoyancy and stability; but in most classes of warships, more on the latter than on the former. It being further assumed that no practicable amount of armor or other protection will be sufficient to prevent the piercing of the shell, it results that safety, with reference to both buoyancy and stability, will require the subdivision of the internal volume of the hull in order to minimize the consequences of a rupture of the skin at any given point. The author thus takes it as a general principle that "whenever internal arrangements necessitate or favor a subdivision in compartments, these ought to be made watertight." The general effect of the flooding of such compartments is then discussed, the various cases being noted where the compartment is completely or partially filled, where it contains imprisoned air, and where it lies partly above the level of the outside water.

In order to first discuss certain general points the author takes a box-shaped form, thus furnishing a simple case for the fundamental discussion of the questions involved. The application of the formulæ and conclusions to the case of the ship-shaped form are then discussed with reference to the actual problems presented. The discussion of the relative effects of a broad transverse central, or of narrow longitudinal side compartments is

also taken up, and with reference to the consequences in any concrete case.

The application of these general principles to the structure of modern warships is then taken up and the various practicable dispositions are discussed. With reference to the lower part of the structure the author concludes that the immersed portion of the shell should always, as far as the size of the ship will permit, be doubled, and further that the vertical keel should not be made watertight. The effects of wing-passages bulkheads, of side-bunker bulkheads, and of relatively small subdivision fore and aft are then discussed and their advantages pointed out with reference to the requirements of the general problem under discussion.

The author further concludes that the fitting of a watertight longitudinal center-line bulkhead is objectionable on the score of stability, and should not be fitted unless absolutely required in order to assure the efficiency of the ship in certain respects, as, for example, between the engine rooms on a twin-screw ship in order to avoid the possibility of both being flooded as the result of a break on one side.

The paper is accompanied by numerous diagrams illustrating various methods of subdivision, and with especial reference to the particular features presented for consideration by the author in the general discussion of the problem.

DISCUSSION.

MR. LUCAS: It is my opinion that the possibilities of the protected cruiser have not been exhausted yet, and it may be possible to find arrangements in a protective-deck position that will enable the protected cruiser to retain its entire reserve buoyancy and a very large percentage of its stability, even for injured condition. I believe at the present time the position of the protective deck is chosen too much in regard to the so-called "normal condition" of the boat, while I believe that an improvement in buoyancy and stability can be realized if the position of the protective deck would be chosen in regard to the maximum load condition. If the space below the protective deck would provide buoyancy in excess of this maximum full-load weight it seems nothing except perforation of the protective deck could deprive the boat of its reserve buoyancy. To obtain this maximum load position always for fighting purposes it would be necessary to provide a certain amount of water ballast that would take the place of consumed coal ammunition or stores. With the immense pumping arrangements, however, that every warship possesses, and the large subdivision of water bottom and watertight compartments, this would prove no difficult task. The cruiser could steam at high speed in a cruising condition; it would be permissible to have a rather steep angle for the slope of the protective deck, thus widening the area of the flat top very considerably, even to such an extent that it would be possible to realize positive stability if almost the entire superstructure is destroyed in regard to providing buoyancy leverage. If such a thing would be possible the protected cruiser certainly would lose a great many of the objections that are justly raised against it at the present time and the fine speed possibilities that are in this type of vessel will always retain favor for it in all navies.

MR. HILL: If the members of the society have not

heard of the late collision in the English Channel squadron it may be interesting to state that the *Hannibal* collided with the *Prince George* one night. They were running at night without lights, and in ramming the latter made a long broken cut fifteen feet in length and five other holes broken through the surface. The rudder was disabled and the electric-light plant put out of commission, so that the ship was left in absolute darkness, but they managed to get the watertight compartments closed. The water kept gaining and she began to settle at the stern, but they finally succeeded in stopping up the jagged holes and at once set the engines going ahead at full speed. The pumps managed to hold the water down, so that running all night they reached Fayall in France next morning and managed to navigate her into the harbor, and then got a big cruiser alongside of her, pumped her out, and in 117 working hours, working with the men on the fleet alone, with no assistance whatever from the shore, they repaired her so that she was sent back to England, passing through a storm in the Bay of Biscay and reached England perfectly dry. They were both under way at 12 knots. I was with the English fleet during the summer maneuvers and I noticed in every case everything that approached to a protected cruiser was kept carefully under the wings of the mother battleships as long as any armored cruisers were in sight, and were absolutely useless except keeping a certain number of boxes, officers, and men in rather an exposed position.

MR. TAYLOR: With regard to the *Victoria-Camperdown* collision, I think that was at low speed, not over four knots, and I think in other cases also the cause of actual collision was they were trying to avoid a collision instead of trying to ram, and therefore the result was that the ramming ship struck the ship that was rammed at a comparatively low speed. The conditions would be rather different if the ship struck were rammed by a ship going at ten or twelve knots, and if a large ship strikes another going ten or twelve knots it will probably go down with her. There is no question about that.

I fully agree that the large-sized protected cruiser may now be considered an obsolete type, although there is now a movement in our service to revert to the large-sized protected cruiser, I think it is a practical waste of money. The protected cruiser which relied upon its sloping deflected deck to keep out the shot or the shell had some justification a few years ago, but the developments of high explosives and recent increase in the velocity of projectiles within the last ten years have rendered it practically worthless.

The remarks about watertight doors and the necessity for not having them below the water are undoubtedly true, but it seems very difficult in our service to make the practice conform to the theory. We had a case of a ship, the *Texas*, which was designed very much on the German plan; there were no watertight doors in the principal bulkheads below, and to get forward and aft you had to go through a passage directly underneath the protected deck in the center line. The *Texas* hadn't been in commission three months before it was reported absolutely impossible to carry on the work of the ship unless doors were cut in the bulkhead sections below. The doors were cut.

MR. BOWLES: I know the story about those doors very well, and it has a sequel which you may not all remember. Somebody took down the injection pipe on the *Texas* and failed to blank the injection valve, and in order to make sure that it was perfectly tight it was probably set up with a large wrench, and the result was that the injection valve broke and the ship was flooded, and due to these very doors the ship was sunk. That was an accident. At the times the *Texas* was designed the scantlings of the bulkheads were quite different from what they are now, and it wasn't customary to test the watertightness of the bulkheads in accordance with the present practice. It may not be well understood that in the building of all the vessels of the United States Navy at the present time it is customary to test all the bulkheads under a considerable head of water, a greater head than they would be liable to be subjected to under any conditions of damage, and those bulkheads are required to be tight and not to deflect beyond their elastic limits.

COMMANDER HOVGAAARD: Protected cruisers are obsolete; smaller cruisers must be given protection and can never be termed anything but protected cruisers. I maintain it is better to put the armor flat on the side of the ship than to place it sloping as it is on the protected cruisers, because they would not thereby be transformed into armored cruisers in any sense of the word, because the armor will always be very light, and must necessarily be so.

It is quite true that speeds may be much greater in ramming than when the *Camperdown* rammed *Victoria*, but it must be remembered that the *Camperdown* was so seriously damaged by the collision that she drew four feet more forward after the collision than before, and that she might have been placed in a very difficult position. That shows if ships want to ram another ship at high speed they should be prepared themselves for going down at the same time. In the English Navy, where they have attempted to reduce the number of watertight doors, it has led to a great deal of trouble in the service, and they have had to increase the number of doors to one in almost every part of the ship.

NON-CORROSIVE NICKEL-STEEL BOILER TUBES.

BY ALBERT LADD COLBY, GUEST.

ABSTRACT.

In view of the great prominence which has been given recently to the study of marine boilers, the question of the life of the tube has been a most important feature. The paper contains the substance of the writer's interviews abroad in connection with the development and the manufacture of nickel-steel tubes. The tests of these tubes indicate that they will last two and one-third times as long as mild carbon-steel tubes. Their increased strength and non-corrosive properties permit the adoption of lighter gauges than are at present in use. In France the manufacture of the nickel-steel tubes was begun commercially in 1898, and in Germany the following year, and the German, French, and Holland navies at once investigated the merits of these tubes. In France the Ehrhardt process is used, which consists of punching out of a square billet. The following operations are much more numerous than those required for the seamless tube, and frequent annealing of the nickel

steel has been found necessary. The resulting cost is excessive. The nickel-steel tube is made in Germany by the cupping process from disks cut from rolled plates. Although the first high nickel-steel boiler tube was made in America as recently as February, yet so successful has the manufacturing been carried out that 30 per cent. of the nickel-steel seamless cold-drawn marine boiler tubes have been a commercial product for some time, and are made in practically the same number of operations and at but a slightly greater percentage of discard for the manufacture of ordinary seamless tubes. These tubes will successfully stand all the tests specified by the Bureau of Steam Engineering of our navy. Because of the increased strength of the nickel steel a larger gauge may be used, and it is estimated that the saving in weight for the boilers of a torpedo-boat destroyer would be 10.7 tons, and that of a battleship 38 tons. The added cost of the 30 per cent. nickel steel would be little over twice as much in the first case and two and two-thirds as much for the battleship. This extra cost, however, is not prohibitory, considering the fact that the nickel-steel tube will last two and one-third times as long as carbon-steel tube, and when finally taken out has a high market value as nickel scrap.

The author gives Mr. Yarrow's summary of the probable causes of deterioration in a marine boiler, and then describes the latter's comparative tests of specimens of 25 per cent. nickel-steel and mild carbon tubes. All the tests to determine the action of acids in the water, the result of tubes becoming overheated, and the action of superheated steam, showed most remarkable advantages for the nickel-steel tube. Nickel steel has a tensile stress of about one and two-thirds that of carbon steel, and at the same time the percentage of elongation is no less than the carbon steel. An interesting series of tests made by the French Navy to determine the physical properties of a lot of French 25 per cent. nickel-steel tubes is given; and tests conducted by Mr. Yarrow and by the Shelby Steel Tube Company of this country gave evidence of the ductility and the absence of all brittleness of this metal. Another advantage of nickel steel is that it is homogeneous throughout. These tubes are applicable in many lines of engineering, and tests made of them on condensers, superheaters, stationary boilers, and in automobile boilers, where the tube has to be coiled and is made of one long piece, show up most advantageously.

DISCUSSION.

MR. THOMPSON: Assuming Mr. Colby's facts that in the battleships he can save forty tons of weight at a nominal increased cost of \$56,000, then, as each ton on one of our modern battleships that is available for armor or for machinery or for guns or munition costs about \$500 a ton, there is a saving equivalent to \$20,000 in that saving of weight. That would reduce your extra cost to about \$36,000, which is only about one per cent. of the contract price for a battleship. Now, if you can increase the length of time in which the boilers will be effective, two or three times, at an extra expense of one per cent., there can be no question what the government ought to do in a case of that kind and what the government will do in a case of that kind. In a torpedo boat I figure out the situation is even better, because there the cost of each ton available for the purposes of the

torpedo boat is about \$1,000, which makes the increased cost of the nickel tubes only about \$4,000.

Many of the vessels of the battle fleet which I saw this summer under the conditions of actual warfare, broke down, their defects occurring in the boilers and through their crews not being trained and accustomed to handle them at the high pressure necessary. Anything of this kind that would tend to decrease the chances of such elements must be considered of importance.

MR. PRATT: The life of all boilers is practically based on a two and one-third times the life of the tubes, and it is possible to produce a nickel tube which will last two and one-third times the life of the low-carbon steel tube; there is great advantage for the nickel steel, for with the boiler tubes it isn't a question of strength so much—it is a question of having the thickness available for deterioration, and if you can get a tube that will not deteriorate then you can make your tubes thinner and save a great deal of waste.

MR. THOMPSON: There were, at the works of the Waclerk Wire Company, two boilers; one at the time built was built of nickel steel and the other of ordinary steel; which was found after running a certain length of time the nickel-steel tubes became very smooth or polished or glossy, and there was no tendency for oil or scale to adhere to them, and in the case of the other boilers they had become picked and rough and oil and scale would adhere. For several months a careful record was kept—for eighteen months in fact—and the saving in the nickel-steel boiler amounted to about seven per cent. as compared with the other boiler.

THE CHAIRMAN: The Chair would state that in his own experience in one case there seems to arise a doubt as to whether mild carbon steel was not injured by cold bending, so as to cause them to be especially liable to this deterioration by pitting. Other tubes, that is, tubes of proper material and properly bent, did not seem to be affected at all injuriously, but one set of tubes was affected. The effect seemed to center itself at the position where they had been bent cold and seemed to be due to the quality of the material used.

MR. COLBY: I would like to answer the chair in reference to the subject of bending, that in the first place there is absolutely no deficiency in bending in the nickel-steel tube. It will stand exactly the same amount of cold bending as the low-carbon steel will stand. This is illustrated in this bending and flattening test, in which the deformation had been far greater than any requirements which mild-carbon steel tubes are asked to meet. Furthermore, in reference to the local failure of steel tubes, where they are bent, I think there is no doubt that the nickel steel will be more advantageous in this regard, for the reason it does not have as high a contraction of area as the soft-carbon steel. For that reason I think you will find that in practice there will be a marked advantage in the wear of nickel-steel tubes at the points in which they are bent. That is further illustrated in the success which these tubes have met in their introduction in France for the automobile boilers of the Garnier-Suppolet type of steam boilers. There is another property of this 30 per cent. nickel steel which renders it very advantageous for this purpose, and that is, if it is heated red hot and plunged into cold water it softens it and not hardens it; which is exactly opposite

what you would expect from your experience in testing ordinary steel.

CURVES OF FORM OF THE INITIAL CONDITION.

BY GEORGE C. COOK, MEMBER.

ABSTRACT.

In this paper the author presents a general discussion of the various geometrical functions and ratios which depend on the external form of the submerged body of the ship. These are furthermore limited to the so-called "initial position"—that is, ship upright and in normal trim. These various geometrical functions relate to volumes, areas of sections and water planes, center of volume and of area, metacenters, moment for change of trim, form coefficients, etc.

The paper is accompanied by a collection of analytical expressions indicating the operations of integration required to determine these various quantities, and by a series of plates showing the resulting curves in various illustrative cases.

These various geometrical functions and ratios are all well known to the naval architect and form the subject of the usual elementary computations in all drawing offices.

The meeting adjourned until 10 o'clock Friday morning, November 20, 1903.

THIRD TECHNICAL SECTION.

The Friday morning session was called to order at 10 o'clock with Mr. McFarland in the chair, who requested the reading of the following paper:

THE METRIC SYSTEM IN RELATION TO THE SHIPBUILDING INDUSTRY OF THE UNITED STATES.

BY NAVAL CONSTRUCTOR J. H. LINNARD, U. S. N.

ABSTRACT.

The author first notes the recent agitation in favor of the metric system and which culminated in H. R. Bill No. 123, providing for the compulsory use of this system in all departments of the government work except in the completion of the survey of public lands, and for the legalization on and after January 1, 1907, of the weights and measures of the metric system as the standard weights and measures of and in the United States. It is then pointed out that should such legislation become operative all shipyards in which government work is done would need adjust themselves immediately to this requirement and carry out all such work on a metric basis. The author then discusses the general question of the applicability of the metric system to engineering work in general, and in particular to the art of shipbuilding, and concludes that from all practical points of view the present or English system is greatly superior. Reference is made to the advantages of a decimal system of notation, and it is pointed out that such advantages may be obtained by a decimal subdivision of the foot and inch as is now quite common in many fields of engineering work. Reference is further made to the character and size of the units furnished by the metric system, and to their unsatisfactory nature for certain purposes, such as the specification of screw threads.

The author then calls attention to the enormous loss in vested interests which would result from the wholesale

adoption of the metric system, such as machinery for the production of standard structural forms, and likewise all data, tables, drawings, and the entire literature of the art so far as found in the English language. Special reference is also made to the mental concept of size or dimension, which is so necessary a part of the equipment of every good mechanic, and of the difficulty which would be experienced among mechanics in attempting to adjust themselves to a series of units wholly different from those with which they have been acquainted during their entire preceding life.

The paper as a whole forms a strong argument from the shipbuilder's standpoint why such legislation as that proposed in the bill referred to should not be allowed to become operative.

DISCUSSION.

MR. HALSEY spoke at length on this subject, giving extracts from the voluminous evidence which he had gathered to show that the metric system is used very little even in the countries where compulsory legislation has been enacted. He went on to show that although it was claimed by its advocates that in forty-four countries the metric system was used by nearly four and a half million people, as a matter of fact in the thirty countries where he had investigated he found that most of the laws governing the system simply permitted it to be used in the country, and that further investigation revealed the fact that in these thirty countries it was practically never used. Many most interesting extracts from testimony gathered were shown. In Mexico, where the system has been adopted, the greatest confusion prevails in trade for goods such as iron bar bought and sold by the meter in length and the inch in diameter.

He states that the most striking feature of the present movement is that the scientific men favor the metric system while the manufacturers do not. The scientists' system is measuring the thing when it is done, while the manufacturers' system consists in making of things to specific sizes. Therefore, a change for the scientist would simply mean changing his measuring instrument, while the industrial change would require a complete change of the line of sizes. The scientist's argument is always a measuring argument, never a maker's argument. In closing the speaker stated that if the society is to go on record against the bill now before Congress for the introduction of the metric system, to have any effect a resolution should not be aimed against compulsory legislation, but rather against any change at all, for the present bill is not termed for compulsory adoption.

THE CHAIRMAN: I have given some attention to this subject and I was called before the committee on Coinage, Weights, and Measures as the representative of the company with which I am connected, under the belief that I would advocate the change to the metric system. The people there supposed I was very progressive, and I believe they were very much disappointed when they found that my ideas of progressiveness did not coincide with theirs; and I tried to make out that point that Mr. Halsey brought out very clearly, that the men who are advocating the measure are simply the scientific men—men who simply measure things after they are made—while the manufacturers, as far as I could find, were opposed to it. We had an estimate made for my company as to how much it would

cost to make this change, and found that to make the necessary changes in chucks and tools and measuring instruments and things of that sort in the shop would cost nearly half a million dollars, and to change our drawings over would cost about a quarter of a million more. And the expression Mr. Linnard used about the importance of round numbers, I tried to emphasize that in my testimony; but it was a flat failure; the people not being manufacturers didn't appreciate it. I invited them to come out and go through our plant and let us show them what it means to make the change, but up to date they haven't come. I am still hoping that they will.

MR. FORBES: Mr. Halsey has proved, if he has proved anything, that we are in a state of chaos. It seems the gentleman who read the paper believes we are going to live forever. Can't we stand it for a short time for the benefit of by and by? Certainly the argument the gentleman presents proves we ought to do something, and it seems to me that after we have got a good start in any way to standardize measures throughout the world we ought to stick to it and not slide off to something else. I fail to see where the expense is going to come into my shop in adopting the system of measurements. I have no trouble at all in making my men work on the metric system, but I generally tell them I want them to make that so many lines long, so many marks, and they come out all right. I don't have any trouble with that. Talk about accuracy! I never saw a bar-rolled iron that was accurate. I never knew a 4-inch bar that was 4 inches; it is always plus. We all know that we have got chaos perhaps in one way, but why can't we attempt to better it and not pull down the structure unless you can give something that has made a decided advance? We cannot afford to batter down this structure of the metric system unless you are going to build up something better.

MR. PEABODY: The point in question is the one that was emphasized by Mr. Linnard in a very temperate and very judicious way, which is: shall the shipbuilding interests of the United States be made to carry the brunt of this when it probably is the worst possible place to try it? If the country can be brought to the place where the metric system is used generally, then the shipbuilding industry will fall in with it; but why should a government action be taken which is going to bear heavily upon one particular department, and that one which has sufficient difficulties of its own? On the scientific side, if the metric system is found more convenient then it is more scientific than any system in common use. I can't see how otherwise it can be claimed to be as scientific or more scientific.

While it is very true most of the papers, scientific sheetings, are using metrical units, if you will take the catalogue of any house in this country or in England selling scientific apparatus, you will find that there is nearly as much apparatus sold as graduated in other systems than the metric as in the metric system. There is no difficulty so far as I have seen in shipping materials to foreign countries on metric orders from a non-metric factory. Take the case of liquids for example. Our standard package for most liquids is a barrel which is called a 50-gallon cask, and holds from 45 to 52 gallons. You seldom will get two casks of the same ca-

capacity; they all have to be gauged; and if a man wants so many liters of liquid shipped to him, it is just exactly as easy to ship that as it is a corresponding number of gallons, because you have got to weigh it anyhow, and it is merely a matter of reducing one to the other.

Metric System Resolutions.

Mr. Hyde presented the following resolutions which were adopted by the society by a rising vote of 40 to 11:

Whereas, A bill for the adoption of the metric system in the departments of the Federal government has been favorably reported in the House of Representatives;

Whereas, We consider that the only effect of such a law will be the creation of a government metric system and the continuation of the existing system in ordinary commerce and industry;

Whereas, The confusion resulting from such a condition of things would be intolerable;

Whereas, We believe the adoption of the metric system of weights and measures by the people at large to be impracticable; therefore, be it

Resolved, By the Society of Naval Architects and Marine Engineers, assembled in annual meeting, that we condemn all legislation intended to promote the adoption of the metric system in this country;

Resolved, That we especially condemn the bill which was reported to the last House of Representatives as one which can do nothing but introduce confusion where we now have uniformity.

ELECTRICITY IN MANUFACTURING PLANTS.

BY W. M. M'FARLAND, MEMBER OF COUNCIL.

ABSTRACT.

The author first notes the great advances which have been made during the past ten years in the application of electricity for industrial purposes, and in particular for the distribution of power to the various points where required in large industrial establishments. The various advantages of such mode of distribution as compared with distribution by belts, shafting, steam piping, etc., are pointed out, and this section of the paper furnishes an excellent general comparison of these various methods of power distribution.

The author then passes to a discussion of the relative advantages of alternating and direct-current machinery, and points out that on this point opinions are still divergent, and presents simply his own views based on a wide experience with such machinery, and with a firm where both types are manufactured. In this connection the author suggests that had the induction motor been the first to enter the field there would have been little room for argument because its merits are so great that there would have been slight incentive to develop anything else. Due, however, to the fact that the first practicable forms of electric motor were of the direct-current type, the latter acquired a vogue which naturally belongs to a meritorious device to which the engineering public is accustomed and upon which it has for some years placed its dependence. The author then compares the essential structural elements of the two types of motor and expresses the opinion that for most industrial purposes the induction motor will be found superior to those of the direct-current type.

The author then discusses in some detail the various

systems of installation, of speed control and variation, and gives numerous illustrations drawn chiefly from shipyard installations. The paper is also accompanied by numerous half-tone cuts showing various examples of such installations, and by a diagram showing the efficiency curves for two typical motors, one of alternate and the other of direct-current type.

DISCUSSION.

MR. HERBERT: There is one point of the advantage for electric drive which came to my attention recently here in the city of New York. A double factory building had two lines of shafting run up on each side of the wall and a fire took place in the basement of one of the buildings and went through the hole in the wall where the shafting went through and followed right up through the belt boxes and gutted the whole building. The safeguard and advantage on account of fire with the electric drive are very evident.

MR. NEWMAN: Several years ago Professor Benjamin of the Key School of Mines estimated that to run a certain plant by electricity there would be a saving of at least 50 per cent. of that necessary to drive it under the old belt system. With the introduction of electric power in the shipyard of to-day we may look for at least 75 per cent. saving.

When a certain plant with which I was connected decided to install electricity we had a contract with the Westinghouse people at which they furnished the motors at a fixed price, and when they came to arranging our small tools we found we could get a 25-horse-power motor to drive the tool shop and so on, at a cost which was not comparable with that under the old belted plant.

The use of the magnet for lifting plates was first drawn to my attention by the sales agent of a Cleveland concern, but it was a rather expensive tool. Our consulting electrician, Dr. Robb, afterwards devised similar magnets for the same purpose at a cost which was really absurd in comparison with the cost of the magnet originally purchased. We tried it in Cleveland with rather indifferent success, and when I made my connection with the New York Shipbuilding Company it was adopted there. I am not sure whether it is used to-day or not; but there is no doubt in my mind that it is an appliance that can be used very extensively and to advantage.

MR. MCFARLAND: I didn't attempt to make this paper a very technical paper because I felt that before this society what is wanted about things of this kind is the results rather than an attempt to go into technical detail. Only yesterday one of our men called my attention to the adaptability of one of the forms of variable speed induction motors to quite a delicate service—paper making—where it had to be handled very delicately indeed in order to give success, and had worked admirably.

DESCRIPTION OF THE DESIGN AND BUILDING OF THE 21,000-TON STEAMSHIPS MINNESOTA AND DAKOTA.

BY CHARLES R. HANSCOM, MEMBER.

ABSTRACT.

This is a very complete account of the arrangement, building, and equipment of two of the new steamships

for the Great Northern Railway Company, building at New London, Conn., by the Eastern Shipbuilding Company. Incidents regarding the selection of the site and erection of the buildings for the new shipyard which was established to build these great vessels form an introduction to the paper. The most novel feature of this yard is the trolley system for handling material above the two building berths. Three heavy steel masts were erected, 300 feet apart, between the building slips, and each supports a crossyard, 174 feet long, extending over the slip on each side. The structure is held in position by wire guys and a strongback placed on the after mast. The crossyards are fitted with tracks on which the carriages supporting the athwartship movable cable travel. The field of operation is divided in two parts by the middle of the yard, and over each belt runs a trolley with a lifting capacity of 5,000 pounds. The system was designed for two trolleys for each field. The electrically-operating machinery is located in a house on the mainmast.

The preparation of the building berths and the method of building the vessels are then described and the special features of construction are considered. There is a longitudinal bulkhead from end to end, from tank to main deck; forward of the machinery space on the tank top a tunnel is built which is watertight, passes through all bulkheads, and contains the ballast and bilge piping. It is entered through door in forward boiler room and has an escape to crew's quarters. The double bottom is 6 feet deep. The decks are supported by box-shaped girders and bracketed to bulkheads by heavy webs, with wide-spaced pillows between bulkheads. Two pairs of deep tanks, one forward and one aft, are arranged for cargo as well as water, and bring the total water ballast up to 5,000 tons. The auxiliary equipment of these vessels is most interesting and in many respects quite novel. The hatches are fitted in pairs, two to each hold, one port and one starboard of the longitudinal bulkhead, making 18 hatches in all. Extensive arrangement for handling cargo rapidly with derrick booms is installed, the winches being of electric drive. Sixteen Niclausse boilers are to furnish steam at 250 pounds pressure to two sets of triple-expansion engines.

The closing pages of the paper are devoted to a description of the launching of the *Minnesota*. The pressure on the forward poppets averaged about 13 tons per square foot, and the launching weight was 11,000 tons. The launch was carried out successfully. A most valuable set of drawings accompanies this paper, including midship section, layout of ways, details of stem and stern, arrangement of anchors and steering gear, engine and boilers, general arrangement plans of the decks, etc. Many fine engravings are also given, showing the ship before and after launching, and also launching diagrams. Coming, as this paper does, from the president of the company, it may be looked upon as authoritative.

In the absence of the author Mr. Main read the above paper.

DISCUSSION.

MR. STANBERRY: The vessel is building under the survey of Lloyd's Register. We have taken great pride in watching the progress of the work under, I might say, almost unprecedented difficulties. The contract, as you see by the preamble of the paper, was taken when there

was no yard, no establishment actually fixed for it, let alone a plant to work with. The building of the ship you might say went on concurrently with the establishment of the yard, and the plant, and the building of the workshops. It is the most unique occurrence, I think, in the history of shipbuilding. Mr. Hanscom, in his paper, makes one reference to the wide spacing of pillar stanchions connecting with the overhead girders, and it reads as if that was the first time in which that system has been adopted under our classification. That is not quite correct, and would cause a little modification. I think in other yards, the Maryland Steel Company and the New York Shipbuilding Company, the system had been adopted and approved by our society.

MR. NEWMAN: I noticed in listening to this paper reference was made to the building of the ship from the middle body toward the ends. This of course is the usual practice adopted on the Great Lakes, where we build under that system and frame our ship as rapidly as possible. The idea of that is that we can get more men in operation than in any other way, and then as soon as she is framed and faired we can build from different stations. In other words, we could plate there a ship 500 feet long in five weeks. I think that is quite a record, and proves rather to me the absence of the necessity of attempting to shear in when you can do so quickly. Some two years ago the point had been raised by the late Mr. Morse as to which end to build the ship from to get the best progress, and we came to the conclusion that the stern was the first thing to start from; that is, we erected our stern post first and built forward. I gave to Mr. Nicholson the scheme to plot out and draw in diagrammatic forms and in different colors the progress of the ship in construction. They had a diagram of the ship on the keel and nothing else. Then we laid the floors in the different stages up, which proved very interesting, and those of you who are practical shipbuilders will realize the difficulties to be encountered in those methods because where the ship has this reverse shape there is practically nothing to hold the ship and the tendency is to hang back. In the first place I mentioned the sheer strake and the stringer did not come quite right, and after we learned the first lesson we got ahead of it and anticipated that difficulty in the next.

I notice further Mr. Hanscom's remarks about the efficiency of the pneumatic reamer, and latterly the thought that has struck me, especially in light constructions where we build with a template system and almost invariably ream and countersink bolts, why not go a step further and drill the work. I think the government, with their light shells and very much lighter scantlings, could consider this subject to advantage, and I don't think the cost would be as surprising as you might expect. The riveting in these ships becomes a very important and serious factor, and after discussing this same question with Lloyd's surveyors and the superintending captain of the Atlantic Transport line of boats on the two ships we were building, we adopted a scheme of increasing our riveting, and in changing we turned abruptly and tapered off diagonally at the ends, and I should say with pretty good results. I think the idea originated with Lloyd's surveyor. These large At-

lantic boats are showing weeps in their deck tanks which are probably due to that one cause.

Mr. Hanscom's reference is also to the longitudinal framing adopted in these ships. I think this can be followed with advantage by many of our light high-speed boat builders. Mr. Hanscom calls himself the pioneer in heavy shipbuilding, and I want to state that hulls 5 and 6 of the New York Shipbuilding Company were but very little smaller, and I think are worthy of note. They were supposed to be sister ships to the *Minneapolis* and the *Minnehaha*. We lifted all the heavy weights from the main deck up to the upper deck, which was condemned by the naval architect, and they have yet to prove their improvement otherwise over their sister ships.

I think another interesting matter, too, in connection with these heavy boats is the riveting. When it comes to driving a 1 1/8 or a 1 1/4-inch rivet in these heavy plates it is a very serious problem, and we resorted to countersinking with a rounded head. In other words, the boat shear strake looked as though they were all strap driven, but they had underneath a countersink which gave very excellent results.

MR. PATTERSON: I will be pardoned, perhaps, if I correct the impression that Mr. Newman has made, that the origin of the design of carrying heavy class of the structure on top is due to the company with which he was formerly connected. Praise, if any, is due to the company with which I am connected, the International Mercantile Marine Company. And in the case of two boats that were first built and not ready, and two more building here in Cramps, the bridge house was worked to form a part of the upper weight. The details of the riveting, which have been explained by Mr. Newman, were first of all carried out in Cramps' yard, and were arrived at after prolonged and tearful experiments. The importance of closing up the plates properly and of getting the large rivets to the right seams was what moved us on two or three occasions in the overhaul of the large vessels owned by us. The title of the last paper mentions the designs of the ship, yet, although there is a good deal of scantling and a good deal of detail, the greater part of the paper is taken up by a description of the equipment. That of course is exceedingly interesting. I should be interested to hear of the displacement. Besides that, I have not been able to see in this paper anything about the weight nor anything about the stresses that are taken care of in that ship, and I expected to have heard also the reasons for carrying out such an extensive system of longitudinal framing in such a ship in which the racking strains would probably be excessive. The double girder in the center can hardly be justified. The experience of the owners will prove that. The other details are pretty closely copied from other big ships, which is, of course, to be expected. It is pretty easy to claim, but it is very hard to have accorded to you, a case of originality in the building of a ship to-day; for there is hardly anybody who can build a ship at all of that size anyway except by the experience gained by the other people who have had to pay for it, and by the great registers both of this country and of Europe.

I want to point out the details which have been admired in regard to the tapering off of the riveting, etc.

Both have been in common practice for ten years, and that in the ships of the company that I have the honor to be connected with, in the *New York* and the *Paris*, which are pretty old boats to-day; in detail and strength and almost everything that makes the naval architect pleased, the lines of bulkheads that Mr. Newman has referred to and other parts have been most carefully considered. It was a pioneer operation, and everything was actually designed on paper. The experience of our company at that time had not been great with those big ships, but we had to go by the experience of the distinguished builders of those ships that were presided over by Professor Biles, and even to-day, anybody who is acquainted with the details of that ship, which are entirely due to him, will see how much the people of this country and the shipbuilders everywhere owe to the courage and the originality which were first of all embodied in those two ships.

I am far from trying to minimize the energy and the enterprise displayed at New London. The work done there is an example to all builders and also an object lesson to the investing public. It is not necessary to have an elaborate shipyard. A very ordinary plant can produce anything that can be built, and if there is any justification for a big plant it is that it will get you a perpetual promise of orders.

MR. MAIN: In answer to a remark of Mr. Newman regarding the use of pneumatic tubes, I might say in England Messrs. Yarrow and Thornycroft now drill through all thin plates with pneumatic tube. In answer for Mr. Hanscom, I do not think he intended to claim any originality for the construction of this ship.

In the absence of the author the next paper was read by Mr. Linnard.

ON SHIP'S FORMS DERIVED BY FORMULAE.

BY D. W. TAYLOR, NAVAL CONSTRUCTOR U. S. N., MEMBER OF COUNCIL.

ABSTRACT.

The author first refers to the various methods which have been put forward for deriving forms of ships from algebraic equations, and makes the point that the purpose in view in the method to be presented is not the derivation of a so-called "form of least resistance," but rather the provision of means for varying the characteristics of form systematically between certain specified limits, and for executing such changes more rapidly than would be possible by the ordinary method of hand-made lines, or lines derived by the usual drawing-board methods. The author then notes the unexpectedly great importance of variations in form, and cites examples drawn from experience in the experimental canal showing that moderate changes in the characteristics of form may sometimes produce a surprisingly great influence on the resistance.

In the appendix to the paper the derivation of the fundamental formulæ for both water lines and sections is given, and the equations are discussed in detail. The paper is accompanied by tables of numerical values relating to various constants entering into the equations, and by plates showing the forms of water lines and sections thus derived, and the influence of varying values of the arbitrary coefficients involved.

The paper as a whole shows in detail certain methods which have been found of use in connection with the

investigation of problems in the government experimental canal, and indicates incidentally the complexity of such problems and the extent to which the details of the investigation may be carried.

DISCUSSION.

MR. LINNARD: The main object of the methods adopted by Naval Constructor Taylor, as all his work is highly original, is to evolve a system by which, starting from a given set of lines developed by mathematical formulæ, he can vary those particular forms in a regular and in a mathematically developed method, so that he may know exactly how he is proceeding from one set of lines to another set of lines. In other words, he replaces a haphazard method which failed to give the results he desired. The hand-made model has to be modified entirely by guesswork. The machine-made model is modified by mathematical processes in which the fulness is placed where it is thought desirable to put it and the fining is done where it is thought desirable to do it, and the coefficients and the curves and sectional areas are modified in certain directions without changing the displacement which has been determined upon.

Mr. Taylor's principal difficulties, which he touches on in the paper which I have read, arise from the double curves in the stern. The formulæ developed by him in the paper are not able to give the curves of this shape (indicating) of the double curvature. The other day Mr. Taylor told me that he now found a formula that would climb a tree, and he felt perfectly able to handle this matter.

MR. KAER: We have in the experimental tanks an excellent means of a scientific study of the problem of resistance. It is now not many years ago, when there were only a few tanks in existence. At present there are quite a number of tanks, and the number is constantly increasing. Still, we are only at the threshold of the problem of how best to design a ship for a given speed and a given service; that is to say, we know in a general way what to do, but we can rarely be sure whether we could not so modify our design of a ship as to gain, perhaps, up to 10-20 per cent. The problem is one of extreme complexity and can, like most other scientific problems, only be solved through long and numerous series of experiments, in fact, series of series of experiments. Only if such data are available in a continuous and complete way, will it be possible to draw general conclusions or to tabulate results in such a way that an answer can be had to every reasonable question that may occur in design of the lines of a ship.

Continuing, Mr. Kaer pointed out that different experimental tanks were operated independently of each other, and that the information gathered was not given out. He classed the experiments under two general headings, that for commerce and navy work and that for scientific research, and stated that practically all the work was under the former head. He suggested that a certain time be allotted to carrying on scientific work, which should be published for the general good, such, for instance, as is carried on by the different astronomical observatories. The results thus compiled and published would be of immense value. The speaker looked upon Mr. Taylor's paper as the first step in this direction, namely, that of reducing the design of a ship to mathe-

matic formula, and stated that he should be most heartily thanked for the work. The speaker had suggested to Mr. Taylor the advisability of calculating the curve of a batten considered as a flexible beam.

MR. COOK: May I ask if this table of calculations that Mr. Taylor gives here is applicable particularly to the battleship, or will it do for any vessel with equally good results? Also, at what expense are model experiments carried on for private owners?

MR. LINNARD: I can hardly answer the question in detail asked by the last speaker. I think it should be understood that the system of formulæ and curves laid down in this paper will not enable the tracer to turn out a ship, but will aid the expert naval architect, and their principal use at the present time is in determining within given principal dimensions and displacements the effect of variations of form within those limits.

COLONEL STEVENS: I have just had two models tested and the cost was \$350 for the two, which about includes everything from the drawing of the lines. The lines were fair as lines are made fair in the drafting room, and sent to Washington, and the models were produced there and tested. The deposit requested was \$500, of which about \$150 was returned.

FOURTH SESSION.

The president called the meeting to order.

MR. LEWIS NIXON: I beg to call the attention of the society to the fact that we have suffered a loss by death of a number of the prominent members of this association, among whom were Chief Engineer D. P. Jones, U. S. Navy, Henry G. Morse, George Pierce, Irving M. Scott, Henry Steers, William R. Drake, and Professor R. H. Thurston. The loss of these gentlemen is a distinct loss to the entire engineering fraternity of the United States, and I am sure I am voicing the sentiments of this society in moving that a committee of three be appointed to prepare appropriate resolutions of sympathy for forwarding to the families of the deceased. I make that motion.

The motion being duly seconded and put to vote, was unanimously carried.

DISPLACEMENT AND STABILITY CALCULATIONS BY IMPROVED METHODS.

BY W. S. LELAND, MEMBER.

ABSTRACT.

In this paper the author presents the results of certain investigations relating to the arrangement in detail of some of the well-known computations for the geometrical qualities and functions of ship-shaped forms. These arrangements have been worked out with special reference to the use of students in classroom work, but the author believes that similar methods might be employed for actual shipyard calculations.

In the details of the arrangement various combinations of the trapezoidal, Simpson's, and Tchebycheff's rules are employed, together with mechanical integration where appropriate for stability computations. Comparisons are given showing the number of figures and operations required according to various arrangements of the computation sheet, and the gain by the use of the arrangement suggested is shown.

The paper is accompanied by sample sheets and forms, and by diagrams illustrating the methods of subdivision and representation employed.

THE CHAIRMAN: Gentlemen, Mr. Bauer's paper, No. 18, will now be distributed and considered as read, and discussed as a part of Prof. Leland's.

A GRAPHIC METHOD FOR THE CALCULATION OF THE STABILITY OF SHIPS.

BY M. H. BAUER.

ABSTRACT.

The author first calls attention to the fact that the methods hitherto employed for calculating the stability of ships have had as their object the determination of the lever arms for the ship in one given trim only, and heeled by an external force perpendicular to the length of the ship. He also points out the well-known fact that whenever a ship of ordinary form heels transversely the center of buoyancy moves forward or aft to some slight extent, and the heeling is thus accompanied by a change of trim as well. While this latter movement may be unimportant for ships of full form in normal trim, yet it may in special cases increase to a very considerable amount, as in the case of empty cargo steamers with machinery well aft, or ships with leaky end compartments.

In order to take proper account of all such cases the author proposes a series of positions of the ship, involving changes in displacement, heel and trim, and for each one of which the lever arms are computed with reference to both longitudinal and transverse axes. The number of variations in draft is three, for each of which the ship is given three positions in trim, and for each of the latter, three angles of heel. This gives twenty-seven selected positions of the ship for which the actual location of the center of buoyancy is found, thus giving in each case the two components of the total lever arm, one relative to inclination about a longitudinal axis, the other about a transverse axis. The determination of these various arms is supposed to be made by the aid of the planimeter and integrator, and by processes involving the usual and well-known mathematical formulæ which relate to this problem. When these component arms have been thus determined the values are plotted in a series of ways, as a result of which the arms corresponding to any specified set of conditions may be determined by reference to the suitable curve. The "graphical" character of the paper has chief reference to these methods of reducing and plotting the information furnished by the computations, in such manner as shall most conveniently furnish the values of the righting arms for any specified condition lying within the range of the investigation.

The general principles involved in all such graphic methods are entirely familiar to every naval architect and have been long used by him for like problems, and in particular for the usual stability problem where the change of trim is not taken into account. The novelty in the present paper consists chiefly in the application of such methods to the more general problems where change of trim is taken into account, and where the final stability arm is considered with reference to its two components, as noted above.

DISCUSSION.

MR. MAIN: Prof. Leland says there is nothing new under the sun. It has been my own experience sixteen years ago to use a displacement sheet, which I think is

much in advance and cuts the work down much shorter than Prof. Leland's methods. I would like to ask him what he does in the case of his end ordinates? He says here, "The end ordinates being zero are unaffected by the multipliers." Now, we know as actual ship-builders that end ordinates are not zero. I have a copy of the sheet here which I would be pleased to leave with the secretary to be entered with the remarks. It gives transverse metacenters, centers, and the binary factor of water line and amidship areas also. That sheet there was probably figured up about fourteen years ago for a very small boat.

MR. LELAND: In answer to the gentleman, if the end ordinates happen to have any value whatever, it is not at all a difficult matter to record one-half the amount of that value and multiply by 2, and in the ordinary form of vessels if the first and last stations are taken at the end perpendiculars there is no appreciable value to the ordinate in most cases, and with reference to the repetition of 3, 5, and 7 I would call attention to the fact it is stipulated in that paper these sheets were prepared specially for classroom use, and it didn't seem to me advisable to complicate the matter.

NOTES ON THE LAUNCHING OF THE CRUISER CHATTANOOGA.

BY MASON S. CHACE, MEMBER.

ABSTRACT.

In launching the *Chattanooga*, the problem which presented itself was to stop the ship without shock, once afloat, before she had moved in the line of the launching ways more than 283 feet; the width of the Staten Island sound opposite the shipyard, from the end of the launching ways to the limit of the water deep enough to float the *Chattanooga* being 575 feet, this vessel having a length on the load water line of 292 feet. Special local conditions made it impracticable to swing the ship around with the tide by the use of stern anchors, for the tide drops two feet before the direction of the current changes. The method employed to check and stop the ship consisted in using a mask secured to the stern at the after edge of the rudder, together with a series of rope stops on each side of the ship, connecting at intervals to bow chains, with two fixed ground chains laid outside the groundways and parallel to them. The stops were arranged to break in sections, starting as soon as the ship was afloat.

The data for the ship, the ways, and the launching are recorded, and the method of lubricating and the arrangement of the mask and rope stops are all carefully given. Considering that the retarding action of the mask is but slight at slow speeds, increasing with the square of the velocity, that it has but little effect when the vessel first enters the water, and that it can be quickly and easily constructed and easily removed after the launch. The mask is recommended by the author to more extensive use. The paper is followed by some valuable drawings with launching data.

This paper was read by Naval Constructor F. S. Smith, in place of the author.

THE CHAIRMAN: It has been proposed that the three papers upon launching shall be read, and the discussion take place upon them all, so that the next paper to be read by Mr. Robinson will be Mr. Groesbeck's.

MR. LEWIS NIXON: There has been a meeting of the council in the other room, and they have decided to recommend to the full body of the society that the price per copy of the first five years' proceedings of the institution be reduced to three dollars a copy, and I therefore make the motion that the recommendation be approved by the full society. (On motion duly made and seconded, it was voted to concur in the recommendation.)

NOTES ON SIDE LAUNCHINGS.

BY ASSISTANT NAVAL CONSTRUCTOR WM. G. GROESBECK, U. S. N., MEMBER.

ABSTRACT.

This paper is written as a supplement to that presented by the author to the society two years ago on the launching of small boats, as this one deals with the larger vessels, viz., the cruiser *Galveston* and the suction dredge *Benyuard*. Details of construction of ways are given on large sheets, and a classified description of the scantlings of the ways is presented for both these vessels. The paper forms a valuable addition to launching data.

THE CHAIRMAN: Professor Peabody will kindly read the next paper.

LAUNCHING OF LARGE MERCHANT VESSELS.

BY WILLIAM A. FAIRBURN, MEMBER.

ABSTRACT.

This paper presents further facts concerning the launching of the *Minnesota*, already described in Paper No. 11. The subject is taken up in detail, and the operation of launching is considered during the three periods of, first, accelerated velocity as the ship starts; second, that of uniform and diminishing speed due to the water; and, third, the condition of buoyancy from the moment when the stern is lifted from its cradle to the time when the hull is completely water-borne. The statics of launching are considered for the three periods. The most important features in launching a vessel are pressure on the fore poppets and the moment of resisting tipping; the two less important ones are the launching velocity and the control of the vessel. Incomplete launching calculations have too often been made in shipyards, and the data obtained and curves drawn are of little value and oftentimes misleading.

Then follows a description of launching ways and the launching data of the *Minnesota*, given in full. The author then presents the launching data of the *Kaiser Wilhelm II.*, the *Kroonland*, the *St. Louis*, *Korea*, and the four large ships built by the Maryland Steel Company, which, all taken together, form a most valuable compilation. Many tables are given to show the effect of moving center of gravity of a vessel, the pressure under the fore poppets for various positions of center of gravity, the result of varying position of the fore poppets, and the effect of lengthening the ground under-water ways upon the moment resisting tipping. The subject is dealt with in a most comprehensive manner, and original tables, which have been compiled on the above-mentioned subjects, are of value for determining launching constants.

THE CHAIRMAN: Gentlemen, these three papers are now before you for discussion.

DISCUSSION.

MR. SWAN: I would like to make one little addition to Mr. Fairburn's paper. He says that the largest ships that have been built in this country—I suppose he means launched in this connection—are the *Minnesota* and the *Dakota*, and I thought possibly just an outline of the launching data of the *Mongolia* and the *Manchuria*, of the Pacific Mail Company, might be interesting to the society, and appended to the paper. These ships are 600 feet long, 65 feet beam, and about 51 feet molded depth; next to the *Celtic*, I think, the largest ships built in this country. First, the *Mongolia*, launched at Camden on the 25th of July last: Launching weight, including cradle, 9,487 tons, and weight per square foot of sliding ways, 2.48; the weight on the fore poppets, 2,570 tons, and the mean speed of the ship from the time she started to drop from the end of the ways was 7.52 knots; inclination of ways, 11-16 inch; inclination of keel, 9-16 inch. The *Manchuria*, quite recently launched, was in quite a little more further advanced state than the *Mongolia*, and the result was she was quite a little bit heavier. Her weight, including cradle, was 9,937 tons; not very much less than the weight given for the *Minnesota*. Weight on fore poppets, 2,890 tons; mean speed of the ship, 7.11 knots; inclination of the ways, 11-16 inch; inclination of the keel, 10-16 inch. That is, on the second ship there was a slighter inclination, I think, which reduced the amount of backing necessary and helped us out in a number of different ways. Of course, as Mr. Fairburn pointed out in his paper, this results in a considerable increase in the fore poppets, but we found by putting a large amount of soft packing in the neighborhood, about six feet wide, where it came against the ship, and distributing it as much as possible and then shoring up both, the pressure was very considerable. The effect on the ship was not at all bad. In fact, I think she was not damaged in any way.

MR. MAIN: Mr. Chairman, I would like to correct a few misstatements in Mr. Fairburn's paper. He says at the foot of the first page the tipping action invariably leads to serious trouble. I feel he does not speak from experience, although I have no experience myself to contradict this, although I think vessels have been launched from a bank into the water, which had a considerable tipping moment; if I am not mistaken, I think the *Paris* had a tipping moment, and was launched without any serious result. Then, on page 6, he makes some remarks here regarding length of ways, but the *Minnesota* dropped several feet on leaving the ways. On page 9 he gives the tensile strength of the timber there and multiplies the section of the area of one way by 8,000, and he gets a downward force of 145.5 tons. He forgot to multiply by 2, because there were two launching ways for this ship.

If you study these launching curves of the *Minnesota*, which are attached to Mr. Hanscom's paper, you will find the launching curve after the vessel has traveled about 150 feet flattens, but not from reasons mentioned by Mr. Fairburn on top of page 35. The only way we could account for this was the length of the ways in the water was so great we could not get down at low tide to lubricate those ways properly, and when the vessel struck this shortly after starting you can see the effect—it flattened the curve. And as Mr. Fairburn was on

board the ship I suppose he felt the slowing but did not know the cause. I had something to do with the launching and followed it very carefully. I think if you refer to the papers, you will find the friction on these ungreased ways was the cause of that slowing down. And then he says, "It is well to note, however, that the vessel was launched two hours after high water." It was two hours after high water should have taken place, but not two hours after actual high water on that day, because we had a strong wind that blew the water up into the river, and it was only ten minutes after mean high water when she went off. But there was mud sticking on the end of the ways, and that showed there was no chance of her getting into this mud. Some of the ways, when she floated out, had mud still sticking on them, and the curves show that she could not have struck the mud, though most of the people thought she struck the mud and that that was what slowed her down.

He talks then of some ways of checking ships here, and seems to think the German method is good. I do not think it is fair to compare that with other methods, because this ship had plenty of water to slide into. The drags only took place, he says, after she began to float, and such devices as that would not suit in a narrow river where vessels have to be checked almost before they touch the water. And he speaks of the methods adopted in the Clyde of burying chains in the ground. I have seen a few launchings on the Clyde, but I have never seen that over there. These drags are usually made of scraps of chain or logs of wood, and so forth, that may be lying around the ways, and as the ship starts to move she takes up one weight after the other, gradually checking her until she come to rest.

MR. SWAN: There is one question I would like to ask Mr. Main, which he can possibly answer, that I noticed in one of these papers, that relating to the *Minnesota*, the launching weight of the ship is given at 10,000 tons, and in another paper it is given at 11,000 tons, and another says the launching draught was determined to a sixteenth of an inch. I think that sixteenth of an inch is a little close on 10,000 tons, and I wish he would set that straight.

MR. MAIN: Mr. Chairman, Mr. Swan is correct there; a sixteenth is very close. The weight was over 10,000 tons. That was the weight proposed at one time, but the launching weight given includes the weight of the moving ways. The poppets, I think, weighed something over 4,000 tons themselves, and the weight of the ship has been added to since Mr. Fairburn got those figures. I think in Mr. Hanscom's paper the draught was something different.

THE CHAIRMAN: If there be no further remarks this discussion will be closed. The chair might remark that it is probably a laudable tendency that, after a first successful launching, the man takes out his feelings of desperation by putting something in writing on paper.

The next paper was read by Mr. Linnard.

NOTES ON THE PERFORMANCE OF THE TORPEDO VESSELS OF THE UNITED STATES NAVY AT SEA.

BY L. H. CHANDLER, LIEUTENANT U. S. N., ASSOCIATE.

ABSTRACT.

It was the expectation of the author to present in this paper the extended results of experiences at sea with

torpedo vessels of various types belonging to the United States Navy. Due, however, to the fact that the movements of these vessels have not been in accord with earlier expectations, a certain part of the data expected, and, in particular, that covering runs across the Atlantic and *en route* to the Asiatic station, could not be included, and is to be forwarded at a later time. The data presented is put in tabular form and relates to various cruising runs of torpedo boats, either singly or in flotilla, and in various waters of the North Atlantic and West Indies.* The items reported relate to the character and length of the run, the condition of the boat, and all items of an engineering character and bearing on the character of the result. Many of the entries are incomplete, due to various difficulties connected with the taking of completed data on all vessels under observation. Sufficient data, however, is presented to indicate clearly the general character of the results which are to be expected from such craft when steaming at moderate speed and under cruising conditions. The supplementary data relating to runs *en route* for the Asiatic station will add greatly to that already presented, and will make of the paper thus supplemented a most valuable collection of information relating to the cruising operations of vessels of this type.

THE CHAIRMAN: Gentlemen, these are the boats which cost the contractors a great deal more than they got. It is very pleasant to hear anything good of them.

MR. BAXTER: Mr. President, I move that the thanks of this society be extended to the Society of Mechanical Engineers for their courtesy in allowing us to use their rooms during this meeting.

This motion being duly seconded, was put to vote and carried.

THE CHAIRMAN: Before putting the question on the adjournment, the chair desires to announce that the council has received and accepted the resignation of the secretary and treasurer, Naval Constructor W. L. Capps, now Chief Constructor of the Navy. After careful discussion and consideration of the matter, the council has elected Naval Constructor W. J. Baxter as secretary and treasurer for the coming year.

REAR-ADMIRAL WASHINGTON L. CAPPS, THE NEW CHIEF CONSTRUCTOR OF THE UNITED STATES NAVY.

It is seldom that changes are made in the heads of the engineering departments in the government service, yet within the last few months the chiefs of the two most important constructive branches of the Navy have either resigned or retired. In last month's issue of this magazine was given a sketch of the recently appointed engineer-in-chief of the United States Navy; the following sketch concerns Washington L. Capps, who upon November 1 became the Chief Constructor and Chief of the Bureau of Construction and Repair of the Navy.

Mr. Capps entered the Naval Academy in October, 1880; four years later he was graduated and ordered to the *Tennessee*, the flagship of the North Atlantic squadron, where for two years he served as aide on the staffs of Rear-Admirals Luce and Jouett. He then received the commission of ensign and was ordered to

Scotland to attend the school of naval architecture at the University of Glasgow. Two years later, or in 1888, when he received the degree of bachelor of science, he resigned as ensign and was immediately appointed lieutenant, junior grade, and continued his studies, taking a post-graduate course at the university for another year. He then returned to the United States and was assigned to work in the Bureau of Construction and Repair. During the next six years he saw service in the bureau at Washington and New York navy yard and at Cramps' shipyard.

On January 31, 1895, Lieutenant Capps was promoted to the grade of naval constructor, and in December of the same year was ordered to San Francisco, Cal., as superintending naval constructor at the Union Iron Works. During these years he served on various important boards; was a member and secretary of the Stability Board in 1893-1894, which passed upon the whole question of the stability of naval vessels in course of construction and completed. In May, 1898, he was ordered to the Philippines in connection with the fleet under command of Admiral Dewey, and assigned to duty as technical aide on the staff of that officer. It was while on this duty that he planned for and supervised the raising of the sunken Spanish cruisers *Don Juan de Austria*, *Isle de Cuba*, and *Isle de Luzon*. The following year he was ordered to this country on the *Olympia* and was promoted to the grade of naval constructor with the rank of commander, United States Navy. He was assigned to duty in the Bureau of Construction and Repair and became a member of the Board of Inspection and Survey, continuing this duty until March, 1901, when he became head of the department of Construction and Repair at the New York navy yard, succeeding in that office Rear-Admiral Bowles, who had been appointed chief constructor.

In addition to the various important technical boards upon which he served during the period above mentioned, Naval Constructor Capps assisted Mr. Clement A. Griscom and Rear-Admiral (then Naval Constructor) Bowles in the organization of the *Society of Naval Architects and Marine Engineers* in 1893, and was its first secretary, being succeeded in the office of secretary by Naval Constructor Bowles, and relieving that officer upon the latter's promotion to the grade of chief constructor and chief of the Bureau of Construction and Repair.

The new chief constructor is the youngest rear-admiral in the Navy, and the outlook for his continuing as chief of the Bureau of Construction and Repair for many years to come, following, as it does, many years of such extended and valuable experience, bids most favorably for the carrying out of a definite naval programme and for the establishment of distinctive and effective types of war vessels.

Turbine Transatlantic Steamers.—A new 18-knot steamship to be built for the Union Steamship Company, Limited, New Zealand, is to be fitted with Parsons turbines. Also, the Allan line has placed an order with Workman, Clark and Company, Belfast, for a steamer for its London-Canadian mail and cargo service, of 12,000 tons, 17 knots, to be propelled by twin-screw Parsons turbines.

THE OIL-BURNING FERRYBOAT RAMONA.

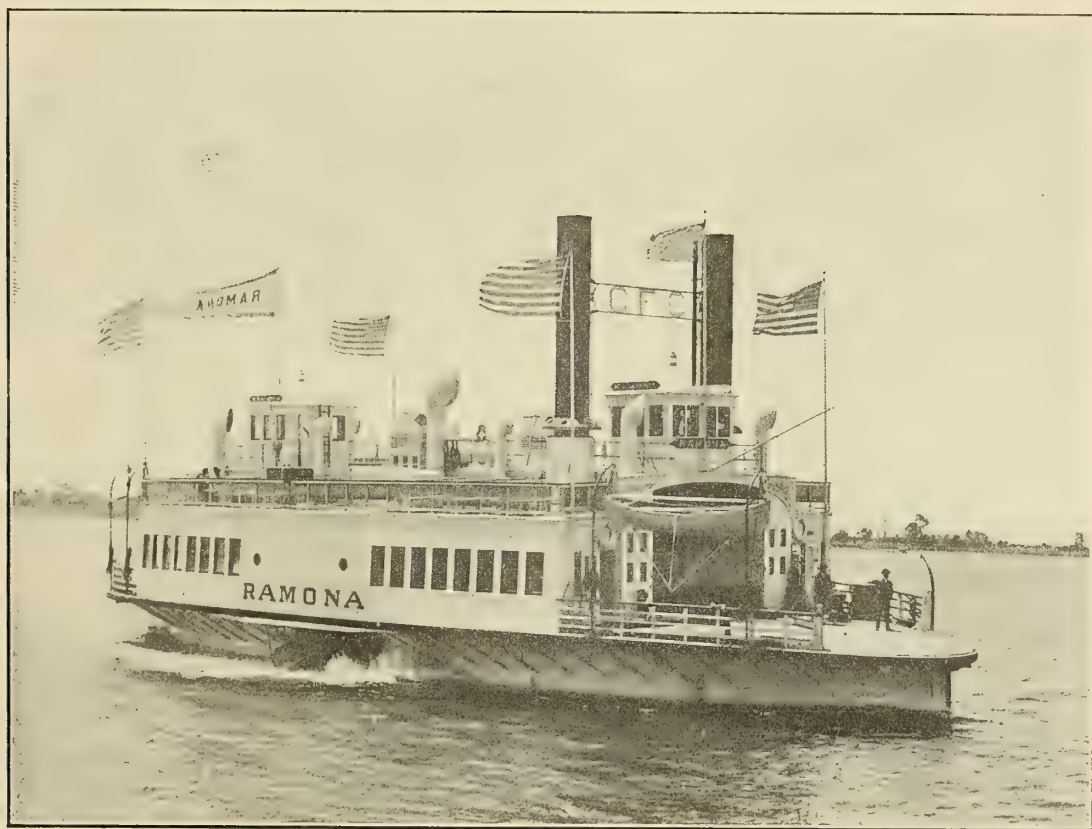
The Risdon Iron Works, of San Francisco, recently completed a fine ferry steamer for the San Diego and Coronado Ferry Company, to be used in the harbor of San Diego.

This vessel is of particular interest for several reasons. In the first place, it is fully equipped with all the auxiliary machinery that usually goes into a regular ocean-going steamer. Also, while the *Ramona* was built for ferry service only, she made the ocean voyage from San Francisco to San Diego, approximately 460 miles, under her own steam. During this trip, which occupied about 53 hours, she was for 24 hours running before a 60-mile-an-hour northwest gale,

boat is the oil-burning system, which is comparatively new in design and of especially practical nature. It will be covered in full later on.

The *Ramona* also has the distinction of being the first vessel to use the steam turbine on the Pacific coast. She is equipped with a 10 H. P. De Laval electric light outfit. This generating set attracted much attention and created a most favorable impression on all who saw it in operation.

The *Ramona* is built almost entirely of selected Oregon pine, her dimensions being as follows: length over all, 130 feet; length between perpendiculars, 118 feet; breadth of hull, 29 feet; extreme breadth, 49 feet; and depth to main deck, 13 feet 9 inches. In



FERRYBOAT RAMONA, BUILT ON THE PACIFIC COAST, EQUIPPED WITH OIL BURNERS.

with heavy and dangerous cross sea, and behaved much better than could possibly have been expected from such a craft. She arrived at her destination in the best of condition and without even as much as a pane of glass broken. On the trip down the coast but one stop was made, and that at Alcatraz landing, where the fuel-oil supply was replenished. For a part of the way she was in tow of the ocean-going tug *Relief*, though using her own engines all the time, the services of the tug being called upon merely to aid the *Ramona* in reaching her destination in time to handle the Fourth of July excursionists that were expected to visit Coronado Beach. She arrived the night before the Fourth, and the next morning was placed in service.

Another point of interest connected with the ferry-

the center of the vessel, for about 70 feet of her length, there is a broad driveway for horses and vehicles of all kinds. On each side of this driveway there are comfortably furnished, well lighted and ventilated cabins for passengers, all the seats being of highly polished hardwood. From each cabin there is a broad stairway leading to the upper or promenade deck, on the sides of which are numerous and comfortable lounging seats. On this deck are situated the pilot houses, one at each end, and from each of them telegraphic signals and speaking tubes communicate with the engine room.

The style and arrangement of the motive machinery is rather unusual, the cylinders being placed on an inclined foundation on either side of the vessel, the cranks working in a recess above the main deck and in

line with the sides of the driveway. There are two high-pressure cylinders, each 20 inches diameter and 72 inches stroke. The working steam pressure is 150 pounds per square inch, and the engines are surface-condensing and work at about 35 revolutions per minute. The indicated horse power is about 670 and the auxiliary machinery indicates about 50 additional horse power. Working at full power the boat can maintain a speed of 12 1-2 knots. There are three 6 and 4 by 6-inch, two 3 and 2 1-2 by 4-inch, and one 3 and 2 by 3-inch duplex Dow steam pumps, all of which are brass fitted and highly finished; there is also one Metropolitan injector and one Dow condenser with air and circulating pump combined. There is one Railton and Campbell patent feed-water filter fitted on the main feed-water line between the feed pumps and the boilers. There are two smokestacks,

one on each side of the driveway, and they make an imposing appearance when looking at the vessel end on. The engine and boiler room is entirely below the main deck and is well ventilated by large cowl-top iron ventilators and ample uptakes. Steam is supplied by two boilers of the gunboat type, 7 feet 9 inches diameter and 16 feet long. There is one Fox corrugated furnace in each boiler, 38 inches inside diameter and 7 feet 2 inches long. The tubes are 3 inches inside diameter and 6 feet long, and there are 167 of them in each boiler. Each boiler contains 924 square feet of heating surface. There is one large vertical donkey boiler.

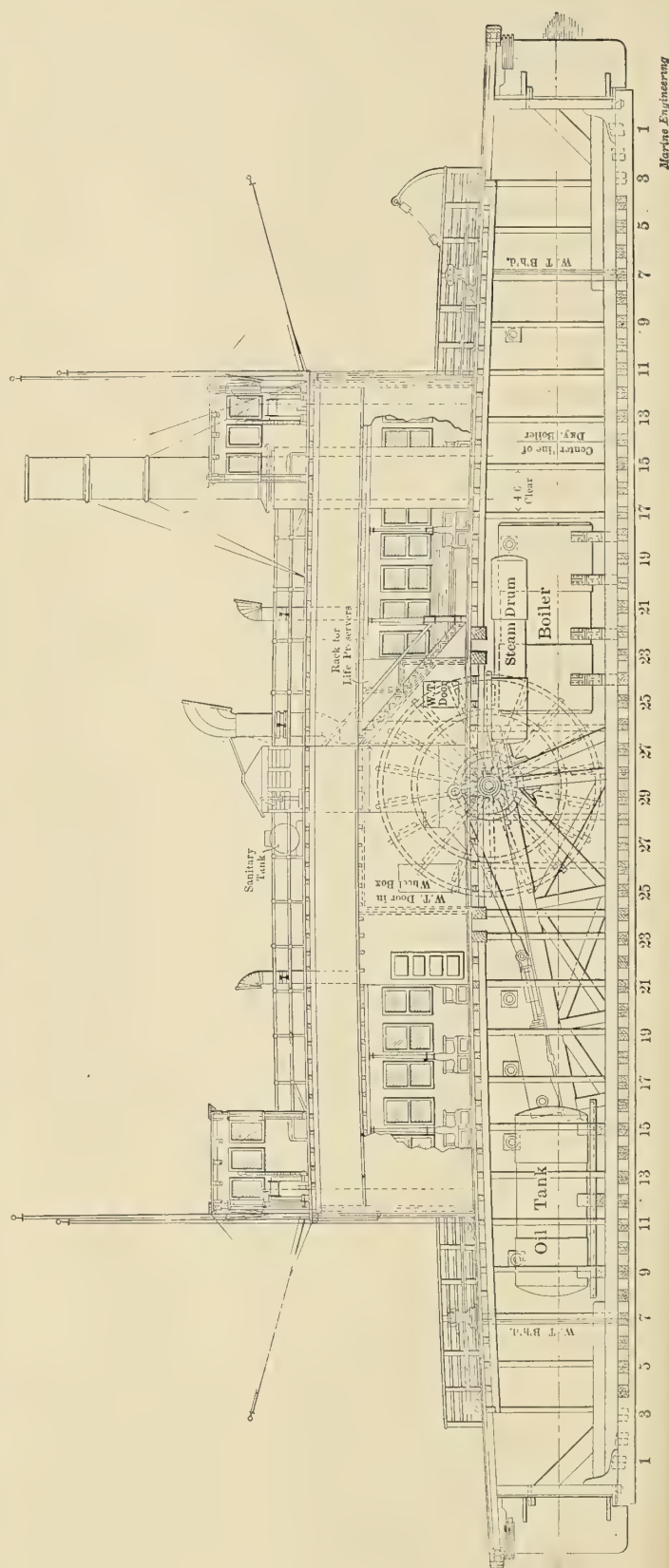
The paddle wheels are 17 feet diameter, built entirely of iron and steel, with the exception of the floats, which are of Oregon pine specially treated with carbolineum. There are 18 floats in each wheel, 6 feet

long and 18 inches wide. There are four floats submerged at a time and the depth of the submersion is 12 inches to top of float.

The vessel was built for speed and comfort, and when put into active operation on the regular run between the ferry slips in San Diego harbor she developed more speed than was called for by the owners, so that *one boiler* was found to be quite sufficient to enable the boat to run on schedule time.

Since going into commission she has been running eighteen hours daily under these economical and favorable conditions.

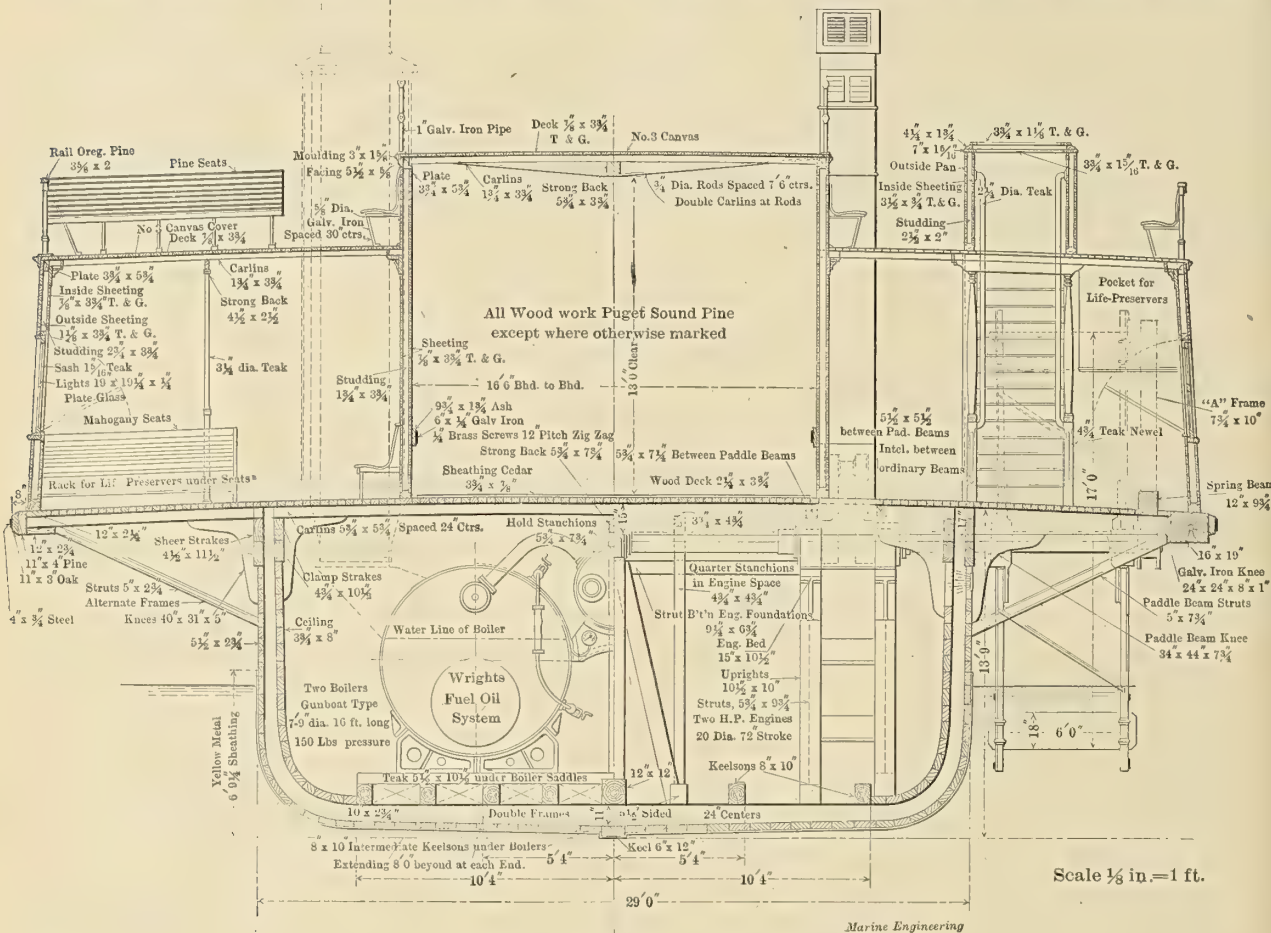
The fuel used is crude petroleum and it is carried in one of two large circular steel tanks that are placed at the opposite end of the hull from the space occupied by the boilers, and right back of the collision bulkhead. The fresh-water supply is carried



the boiler furnace, and the air confined in the regenerative chamber, after it becomes heated by contact therewith, is discharged through properly proportioned angular holes on to the flame of the gases in the boiler furnace. Perfect combustion is thereby obtained, as will be readily seen by a reference to the photograph of the *Ramona*, taken while the vessel was steaming under full power at full speed.

A system of valves placed in the cylinder of the furnace front controls the distribution of the superheated air for combustion. In the upper portion of the regenerative chamber, entirely separated from contact

it is designed especially for the horse power the furnace is capable of developing; it will therefore be seen that with such an installation it will be a simple matter to get the proper regulation in each furnace and have all the different fires working alike. This in itself is a **very** great advantage over the systems that require two and more burners in each furnace, because where there is a multiplicity of burners working in the same furnace it is almost an impossibility for the fireman to determine if all of them are doing their work properly; besides, in an oil-burning vessel, where one fireman has to look after from six to eight furnaces,



MIDSHIP SECTION OF WOODEN FERRYBOAT RAMONA.

with the flame, there are placed semi-steel superheaters and bronze retorts. The superheaters are used for heating to very high temperatures the air or steam that in all other oil-burning systems is used for what is commonly called "atomizing," and the retorts are for the purpose of vaporizing the oil; the gases formed by this combination are led into a burner that is inserted a particular distance into the furnace front, and when the lighted torch is applied the ignition takes place right at the tip of the burner and a flame of dazzling whiteness is afterward carried into the boiler furnace. There is no smoke, and, strange to say, there is not the least evidence of carbon in the retort, furnace, or boiler tubes; all are perfectly clean.

There is but one burner placed in each furnace, and

it is a difficult matter to attend to so many burners and get the proper results. There is only one way an oil-burning fireman can regulate his fire, and that is by his eye. If he has but one burner in a furnace, and he knows his business, he can set his fire in a few seconds; but if he is burdened with two or more burners in each furnace, and one or more of them are working badly, he has to lose a great deal of time and patience in trying first one and then the other before he can get perfect combustion and a fire that will do the furnace justice. And where the man has from eighteen to twenty-four burners to look out for under such conditions, and at the same time keep up the required pressure of steam, it will go without saying that the life of the oil-burning fireman will be much harder.

In the front disk of what the Wright Company calls its "regenerative furnace front" there is a large circular door that works on trunnioned hinges, and through these trunnioned hinges the superheated air or steam and vaporized oil pass from the superheater and retort to the burner. This door is for the purpose of entering the boiler furnace whenever necessary, and, by reason of its working on hinges as described, it can be opened and closed without in any manner interfering with the steam, air, or oil connections. This is a very great convenience indeed.

The burner, while being very simple to operate, is, nevertheless, the result of much study and mechanical skill. It is made of a fine grade of bronze, the best quality of tool steel, and heavy hydraulic pipe. It displays the highest class of workmanship, and, being self-cleaning in its operation, it will be an impossibility for any foreign matter to lodge within its various passages. It is built on the principle of the breech-loading gun; and if it should ever become necessary to remove it from the furnace, the same can be accomplished in a few seconds by simply removing the breech block and withdrawing the tube. Because of the peculiar construction of the breech chamber, the necessity for interfering with the oil, air, or steam connections whenever it is necessary to withdraw the burner from the furnace, is entirely done away with, for once these connections are made up there will be no need whatever to interfere with them. The Wright burner is believed to be the only one that embraces this very simple and important feature. When a burner can be withdrawn from the fire, examined, and put back again at work in less than thirty seconds, the worth of this breech-loading-gun feature of this particular burner will be appreciated.

The regulation on the Wright burner is so very fine that the flame can be held almost at the ignition point or thrown twenty-five feet away, just as the operator desires, and all that is required to govern the passage of the different gases on their way to the tip of the burner, is one little wheel. The whole system seems to be as near perfection as anything can be. It seems that the problem of how to handle crude petroleum at its normal temperature has been solved, without having to pass it through the bulky and, in the eyes of many, dangerous oil-heating tank.

With the Wright system there is no need whatever for the oil-heating tank, with its complex system of thermometers, pressure gauges, relief valves, and gauge glasses, all requiring the closest attention; in its stead there is used the bronze retort that will withstand a pressure of one thousand pounds.

Vessels Lost and Condemned During 1902.—A statistical summary compiled by Lloyd's Register for the vessels of 100 tons and upward totally lost, condemned, etc., during the year 1902, shows that the total for all countries amounted to 233 vessels of 308,182 gross tons. The greatest of the losers were, of course, Great Britain and her colonies, whose losses numbered 101 vessels of about 134,000 tons. Half of these were wrecked, and the rest made up of 3 vessels abandoned at sea, 3 burned, 14 lost in collision, 8 foundered, 12 missing, and one the reason of whose loss is unknown. The next severest loser was Germany, followed by Spain and Norway.

Official Trial of the Cruiser Denver.

On October 22 the U. S. S. *Denver* ran her first official trial over the Cape Ann course, and failed to make the contract speed of 16.5 knots. It will be remembered that the *Denver* and class are a new type of comparatively slow speed and full form with large steaming radius, it being the intention to have them efficient, comfortable cruisers capable of maintaining a speed nearly equal to that under trial conditions.

The *Denver* is 3,200 tons trial displacement; full load displacement, 3,500 tons; length, load water line, 292 feet; extreme length, 208 feet 2 inches; breadth, 44 feet; and mean draft, 15 feet 9 inches. She is fitted with two sets of four-cylinder, triple-expansion engines, 18, 29, 35 I-4, and 35 I-4 inches diameter by 30 inches stroke.

Steam is supplied by 6 Babcock and Wilcox boilers of the regular marine type, giving a total grate surface of 300 square feet and a total heating surface of 13,200 square feet.

The following are some data from the trial:

Average steam pressure at boilers.....	254 lbs.
I. H. P. per square foot of grate.....	19.18
Pounds of coal burned per hour.....	12,200
Pounds of coal per I. H. P. of all machinery....	2.1
Pounds per square foot of grate.....	40.6
Heating surface per I. H. P.....	2.29
Average temperature in uptakes.....	685 degrees
Average air pressure in stokehold.....	.9 inch

The efficiency of the heating surface is well shown by the low ratio of H. S. per I. H. P., and the large amount of coal burned per square foot of grate with such a small draft is practically unequaled.

The trial was conducted under most unfavorable weather conditions, and, after running over the course outward at approximately trial speed, one of the circulating engines broke down and caused a delay of one and one-half hours before the return trip was made. The total collective I. H. P. of the main and auxiliary engines on trial was 5,755. Hand-picked Pocahontas coal was used. Although the trial speed was not reached, it was not because of lack of steam, for the boilers gave most excellent results.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 109 vessels of 43,975 gross tons built in the United States and officially numbered during the month of October, 1903. The largest steel steam vessels included in these figures are 8 vessels which were built on the Lakes and aggregate 35,645 gross tons.

Electricity on the Erie Canal.—Experiments have recently been carried on for determining the value of different systems of electric haulage on canals. A section of about three thousand feet on the Erie canal at Schenectady was equipped with the Wood system, consisting of the duplex mono-rail carried on low poles. A motor runs on this rail and takes current by means of a trolley from a wire above. Four 40-horse-power motors are used to tow the barges by means of a tow line. Other experiments have been made on the Erie canal by F. W. Hawley with motors placed on the boats, supplied from trolley and wire above, and by Mr. R. Lamb, whose motor traveled on an aerial flexible cableway.

Trial of the Maine's Boilers.

The board appointed to investigate the condition of the *Maine's* Niclausse boilers has completed its test and submitted a report. In general the report is favorable to the boilers, but condemns the arrangement of the evaporators and distillers on board.

The board was composed of Captain J. A. B. Smith, Commander W. B. Badgley, and Lieutenant-Commander W. M. Parke. The test consisted of a run from Hampton Roads to Culebra, Porto Rico, and return. There are twenty-four Niclausse boilers installed on the *Maine*, arranged in three groups. The total grate surface is 1,353.6 square feet; the heating surface, 53,343 square feet; and the indicated horse power, 17,848. Forced draft on a closed fire-room system is provided by 12 Sturtevant blowers.

In addition to the vessel's engineer force of 225 men, 78 experienced men were taken on for the run. The run down, 78.37 hours, was at an average speed of 15.1 knots, and the return, 76.3 hours, at 15.9 knots. No attempt was made to force the fires. The boilers on the run down gave no trouble and there was no difficulty in getting at times 115 revolutions of the main engines. The boilers responded quickly to the varying demands for steam. The coal used going and coming was 1,473-1,528 tons. The average rate of combustion per square foot for the run north was 16.45 pounds, and the average coal per I. H. P. 2.45 pounds—a poor result, due to the use of too many boilers for the number of revolutions.

The board recommends that the distillers be placed higher up in the engine-room hatch, so as to give a rise to the steam pipes from the evaporator, both for the distillers and for the condensers; that new coils for the evaporators, with composition heads instead of cast steel heads, be furnished and fitted; that baffle plates be fitted in the evaporators, and that removable sheet metal casings be provided for the heads of the evaporators in place of the present unsightly canvas covers. It is of the opinion that in future the entire arrangement of the plant on board ship for making fresh water, and also the arrangement of the pumps feeding it to the boilers, must be radically changed, if water-tube boilers of any design are to be a success. Evaporators should not again be crowded into places so hot that men cannot give them the attention they demand, so that there may be no loss of feed water through leaky valves, nor any chance of a suction pipe full of greasy or salty water going into the boilers.

They say: "This problem of providing fresh water, and of keeping fresh water and salt water apart on board ship, is of the very first importance. It is of more importance than the question of what type of boiler to use, for all types of water-tube boilers depend upon the solution of this problem for their existence." They recommend the investigation of the subject by a board. This board could take up the question of the best type of evaporator and distiller for use on board ship, and the question of main condenser, whether two main condensers should be used in each engine room, and the auxiliary condensers dispensed with. Also the best type of grease extractor, and its location in the feed line, and what further precautions should be taken to keep oil out of the feed water. Part of this additional weight might be made up by a reapportionment

of the machinery weights, looking to the omission of unnecessary pipes, valves, and fittings. The space required for the rearrangement plant should be insisted upon in all new designs. The board believes that the boilers of the *Maine* are fully equal to the work they were designed to do, and sees no reason why they should not continue to do this work, provided they are given the care necessary for any water-tube boiler.

From the experience with the boilers of the *Maine* on this voyage the board concludes that while clean, fresh water is necessary for the life and efficiency of any water-tube boiler, it is no more a necessity for the Niclausse boiler than for any other boiler of the large-tube variety. Forced draft is unnecessary and undesirable for these boilers as installed in the *Maine*, and the board recommends that forced draft never be used with them, but that any increase of power for the engines should in all cases be obtained by adding to the number of boilers in use. This recommendation is not intended to prohibit the use of the blowers with open fire room, for ventilating purposes. The fire-room ventilators should be carried higher, so as to clear the boats stowed in the cradle. This would give improved natural ventilation for the fire rooms, and would permit the use of the blowers for ventilating without having hot air from the fire-room hatches blown back into the fire rooms. The board's conclusion that forced draft should not be used with the boilers of the *Maine* need not, and does not, apply to the same type of boiler differently proportioned.

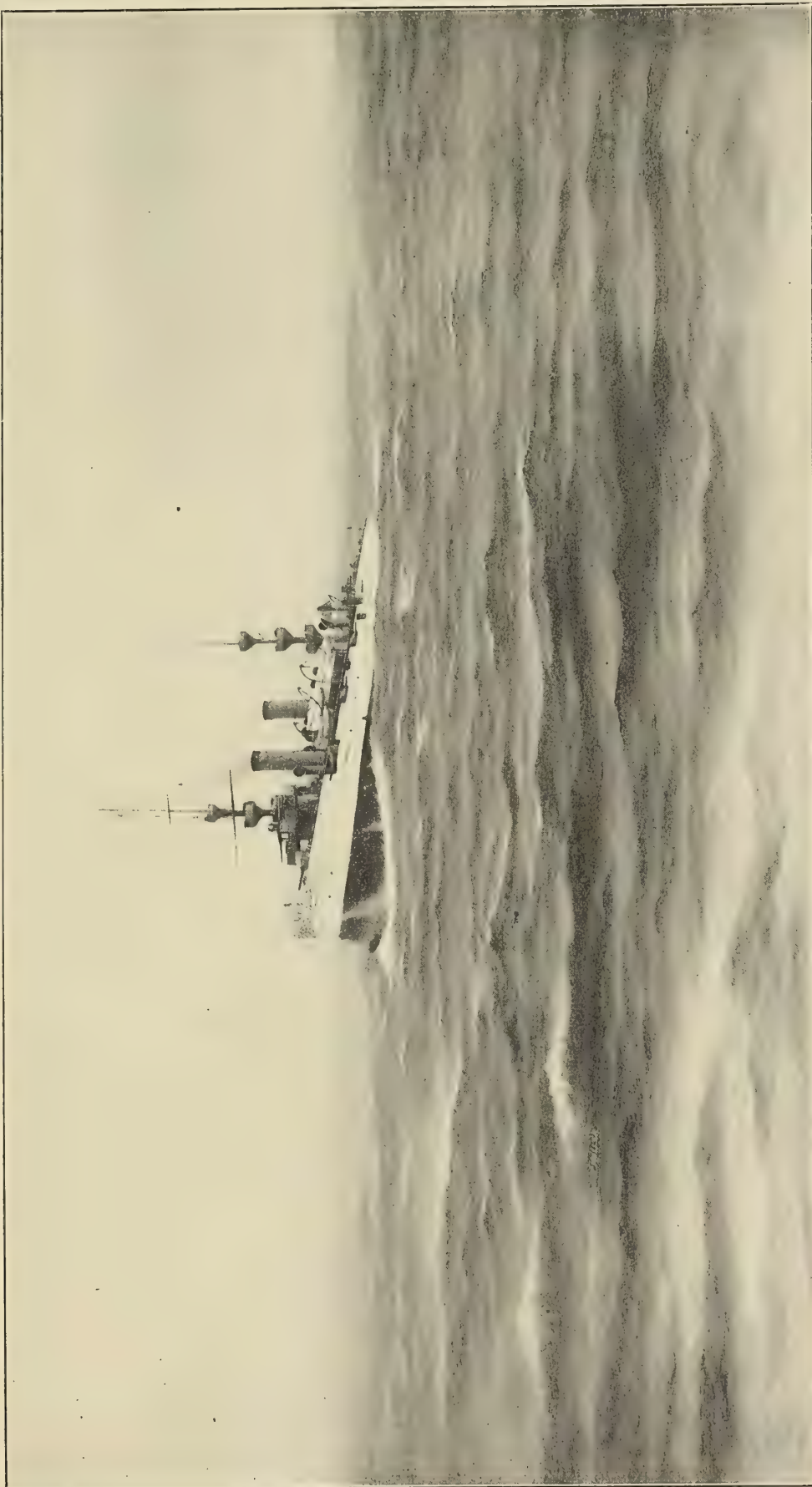
It is recommended that one of the boilers in the Stirling Works be set up and tested under a forced draft strong enough to give a rate of combustion higher than will ever be required of them in service. The test will show whether the limit of capacity is likely to be reached under service conditions, the test to be witnessed by a board of officers detailed by the department.

These boilers of the *Maine* are a fine example of mechanical work, and to keep them in proper order will require the services of men of intelligence and mechanical skill. The board was impressed with the obvious fact that the quality of the personnel is of more importance than the quantity. The water-tube boiler calls for more brain work and at the same time less physical effort on the part of the fireman. To get this quality of fireman he will have to be specially trained.

The automatic feed devices were in use, but the board is of the opinion that they cannot be trusted. The removal of this casting would make the feed checks more accessible than they now are. As to the automatic devices for shutting off the water glasses in case of breakage, there is but one feeling about them, and that is a feeling of relief that they are absent.

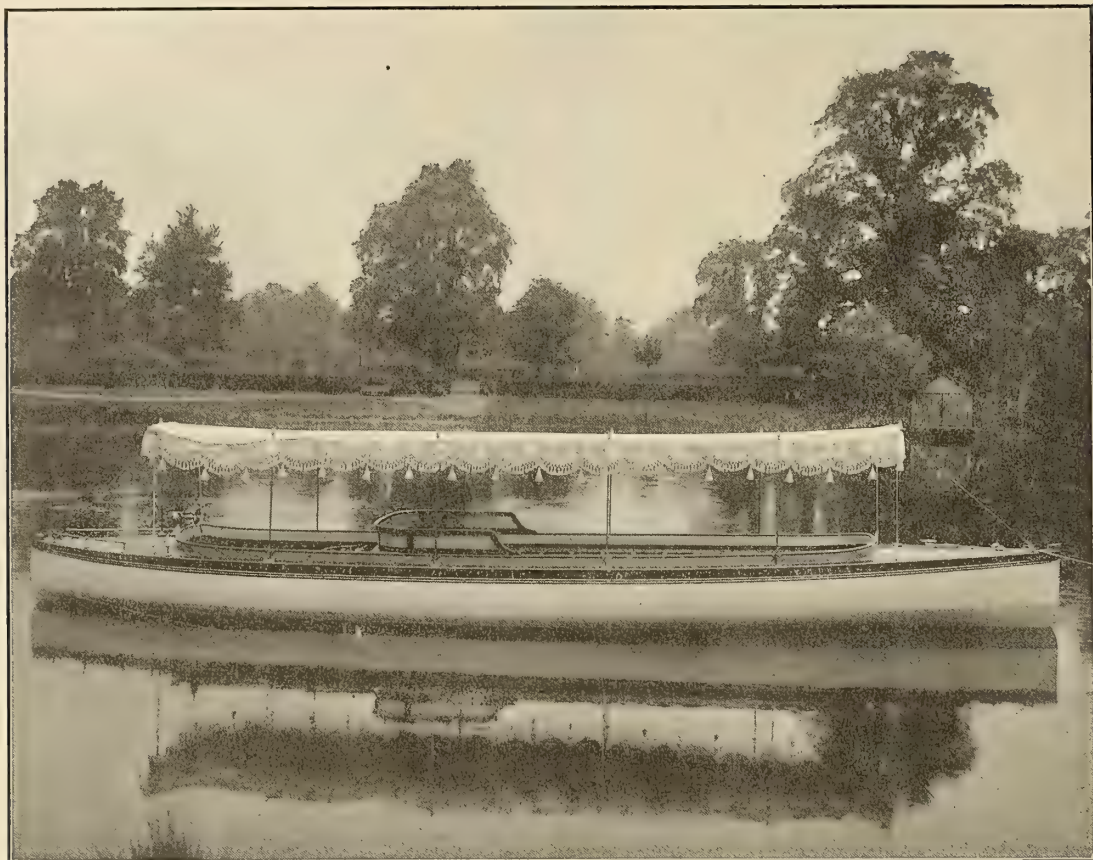
The board recommends that the lagging be taken off all overhead feed pipes in the fire room. The valves in the fire rooms are conveniently placed, and the steam gauges are plainly visible. The fire rooms are roomy and convenient, and they are fairly well ventilated.

Change of Ownership.—The *American Shipbuilder* of November 12 appears under a change in proprietorship. The paper, which was formerly owned and edited by Bradley and Howell, is now controlled alone by Mr. Howell. New type and better grade of paper give this well-known weekly an improved appearance.



THE UNITED STATES CRUISER NEW ORLEANS IN A HEAVY SEA.

[Photograph Copyright, 1903, by E. Muller.]



GASOLINE LAUNCH BUILT FOR KING EDWARD VII.

Gasoline Launch for the King of England.

The views presented on these pages are taken of the new launch for His Majesty King Edward VII. built by Tagg and Sons, of East Moulsey. The launch is 32 feet over all, 6 feet beam, and 2 feet 9 inches deep. From the sectional drawings it will be seen the large gasoline tank is placed forward of the water-tight bulkhead. The main body of the launch is finished in teak, handsomely upholstered cushions being provided. Aft of the second water-tight bulkhead a 20 horse-power gasoline engine is placed. The launch is built of teak and cedar and is treble-plated, the outer planks running parallel to the water line, the middle strakes diagonally, and the inner ones transversely across the boat.

The gasoline engine fitted in this launch was built by John I. Thornycroft and Company, Ltd., Chiswick, London, and is of the type used in the Thornycroft steam wagon and several very successful high-speed launches. When running at the normal speed of 900 revolutions it will develop 20 brake horse power. The four cylinders, each 4 inches in diameter by 4.3-8 inches stroke, are all bolted to one aluminum bed plate.

From London *Engineering* the following description is taken:

The engine bearers are cast in one with the top half of the crank chamber or bed plate, so that the bottom half may be removed without disturbing the engine. The keepers to the crank-shaft bearings are not formed in the bottom half of the crank chamber in the usual way,

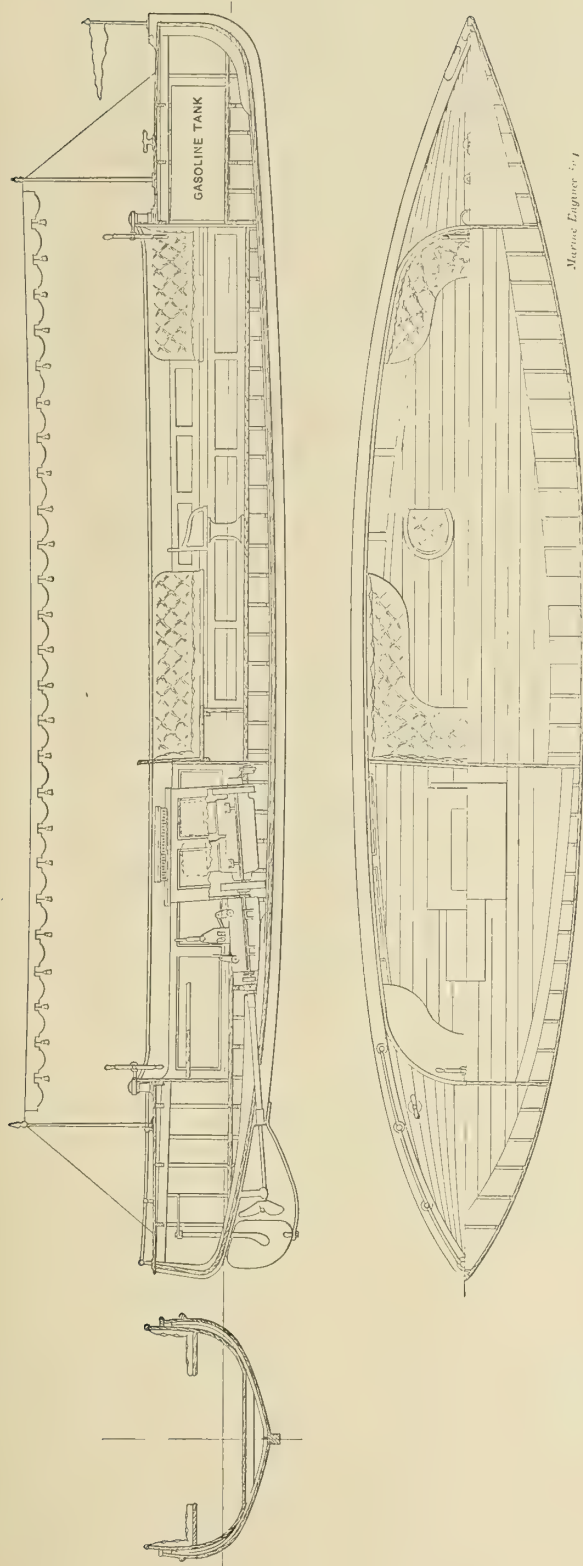
but are quite separate, so that on removing the bottom half the crank shaft is left in position.

The half-speed gear for driving the cam which works the valves, and also the governor, is enclosed in aluminum casings formed in one with the crank chamber. Lubrication is on the splash principle, and the correct amount of oil in the crank chamber is regulated by an overflow pipe.

The cooling water jackets are cast in one with the cylinders, and the water is kept in circulation by what is known as a gear pump, which is driven directly from the crank shaft.

The engine inlet valves are of the automatic type, and governing is effected by throttling the combustible mixture. The handle for starting the engine on first going off is connected to the crank shaft by a chain and ratchet wheel. The two forward exhaust valves have an attachment by which they may be kept open until the engine has got to work, thus relieving the compression on these two cylinders and making starting easier.

A Stethnos carburetor is adopted, gasoline being supplied to it from a small tank, holding one gallon, situated near the engine. The main gasoline supply tank is right forward and has a capacity of 16 gallons; and the two tanks are connected by a copper pipe enclosed in a lead pipe, so as to minimize the chance of leakage. The gasoline is pumped by hand from the large to the small tank. The latter stands in a metal tray, which is drained overboard by a pipe, so that any



SECTIONAL ELEVATION AND DECK PLANS OF GASOLINE LAUNCH FOR KING EDWARD VII.

leakage which might occur would be instantly conveyed away; the carburetor also stands over a tray.

The exhaust pipes are water-jacketed, resulting in the cooling of the gases and making the exhaust more silent.

The speed of the boat, with the engine running at normal revolutions—that is, about 900 revolutions per minute—is about 10 miles per hour; but the engine may be accelerated up to 1,300 revolutions, which will give a speed of about 13 miles per hour. The ignition is on the high-tension principle, current being supplied from two secondary batteries. De Dion pattern sparking plugs are used. External spark pumps are fitted, and, these being always in view, the driver can tell at a glance whether the sparking mechanism is in working order. The tank capacity of this boat is 17 gallons, and it has been found by careful experiment that the engine consumes 1 pound of gasoline per brake horse-power-hour. Therefore, when traveling at the rate of 10 miles per

hour, the engine developing 20 horse power, 20 pounds (approximately 2 1-2 gallons) of gasoline will be consumed at the end of 10 miles—that is to say, the tanks are of sufficient capacity to carry the boat somewhat over 60 miles. It may here be interesting to compare the weight with a steam engine and boiler of equal power with this engine. The weight of the gasoline engine complete, with reversing gear, batteries, etc., and gasoline sufficient to take the boat 60 miles, is very nearly 500 pounds. A 20 brake horse-power double-acting condensing steam engine and boiler complete would weigh about 2 tons, and coal and water sufficient to last for 60 miles would amount to about 2,500 pounds, making a total of 7,000 pounds, or fourteen times the weight of the gasoline engine and fuel.

The Britannic to be Broken Up.—The famous old ship *Britannic*, of the White Star Line, which has seen continuous service from 1874 to 1899 on the North Atlantic, is now in Bremen, where it is reported she will

be broken up for junk. While in the North Atlantic she made 260 round trips between New York and Liverpool, traversing 1,800,000 miles and carrying over 200,000 passengers. When she was withdrawn from the line it was to carry troops for the British government to the south coast of Africa during the Boer war. During her entire service on the North Atlantic, and as a transport, it is stated that she never lost a day from accident or disability, and now has the same engines and boilers that were originally fitted in her. She was built by Harland and Wolff, and, although but 405 feet long, 45 feet beam, of about 5,000 tons and 4,600 horse power, she was in her day considered the crack ship of the North Atlantic. It is interesting to compare this old-timer with the *Cedric*, which was recently turned out from the same yard and is 700 feet long and of 21,000 tons registry. The *Britannic* was the first ship that crossed in less than eight days and made a record for eastward passages of 7 days 16 hours.

MERCHANT AND GOVERNMENT.

Name.	Capital.	Men.	Ships building July 1, 1903		Government vessels building		Merchant ca- pacity.	
			Num- ber.	Ton- nage.	Num- ber.	Ton- nage.	Num- ber.	Ton- nage.
The Neafie and Levy Ship and Engine Building Co., Philadelphia.	800,000	1,400	10	1,949	2	12 900	15	8,000
Burlee Dry-Dock Co., Port Richmond, Staten Island.....	.....	900	7	6,140	2	1,298	..	.....
Bath Iron Works, Bath, Me.....	.....	.....	3	900	2	18 148	..	.....
Harlan and Hollingsworth Co., Wilmington, Del.....	2,000	6	9,741	1	340	..	.....	.....
Crescent Shipyard, Elizabethport, N. J.*.....	850	3	3 545	3	3,548	15	10,000	.....
Fore River Ship and Engine Co., Quincy, Mass.....	6,250 000	4 000	7	17 339	4	49 096	10	45 000
New York Shipbuilding Co., Camden, N. J.....	10 000,000	4,200	3	30,000	2	30,500	6	30 000
Shipowners' Dry-Dock Co., Chicago, Ill.....	800,000	200	1	352	1	140	..	10,000
Jenks Shipbuilding Co., Port Huron, Mich.....	150,000	450	1	4,700	1	718	4	10,000
Townsend-Downey Shipbuilding Co., Shooter Island, N. Y.....	.....	1,200	4	.....	1	626	6	20 000
Total.....	18,000 000	15 200	45	74,666	19	117 294	56	133,000

* Also building two small Mexican war vessels.

MERCHANT ONLY.

Maryland Steel Co., Sparrow's Point, Md.....	3,000,000	2,000	3	8,697	..	.....	..	40,000
Merrill-Stevens Engineering Co., Jacksonville, Fla.....	250 000	200	1	900	..	.....	6	1,500
Risdon Iron and Locomotive Works, San Francisco.....	.....	.....	1	300	..	.....	..	.....
Perth Amboy Shipbuilding and Engineering Co., Perth Amboy, N. J.....	500 000	200	1	2,242	..	.....	15	.....
Eastern Shipbuilding Co., New London, Conn.....	.....	1,800	2	42,000	..	.....	..	.....
Delaware River Iron Shipbuilding and Engine Works, Chester, Pa.....	.....	1,500	4	17,450	..	.....	6	6,000
T. S. Marvel and Co., Newburg, N. Y.....	150,000	400	1	400	..	.....	4	5 000
Total.....	3,900,000	6,100	13	71,989	..	.....	31	52,500

GOVERNMENT ONLY

Union Iron Works, San Francisco.....	.....	.....	..	.....	5	52,700	..	.....
Gas Engine and Power Co., and Chas. L. Seabury and Co., Morris Heights, N. Y.....	.....	.....	..	.....	2	2,170	..	.....
Iowa Iron Works, Dubuque, Iowa.....	150,000	200	..	.....	1	350	..	.....
Geo. Lawley and Son, Corp., South Boston, Mass.....	.....	.....	..	.....	1	166	..	.....
Wolff and Zwicker Iron Works, Portland, Oreg.....	.....	.....	..	.....	1	248	..	.....
Spedden Shipbuilding Co., Baltimore, Md.....	150,000	300	..	.....	1	108	2	9 000
Baltimore Shipbuilding and Dry-Dock Co., Baltimore.....	750,000	500	..	.....	3	1 565	4	8,000
Moran Bros Co., Seattle, Wash.....	2,000,000	1,200	..	.....	1	14,948	..	.....
Newport News Shipbuilding and Dry-Dock Co., Newport News.....	.....	6,500	..	.....	7	96,238	10	50,000
Wm. Cramp and Sons' Ship and Engine Building Co., Philadelphia.....	15,531,000	8,000	..	.....	4	*45,160	5	45,000
Wm. R. Trigg Co., Richmond, Va.....	.....	.....	..	.....	2	13,200	..	.....
Total...	18,581,000	16,700	..	.....	28	216 853	21	112,000

* Turkish war vessel building included.

† Tonnage of one not given.

GREAT LAKES.

American Shipbuilding Co., Cleveland, O., and branches.....	.....	8,000	26	97,520	..	.....	*40	†145,000
Craig Shipbuilding Co., Toledo, Ohio.....	1,250,000	452	4	11,500	..	.....	7	20,000
Total.....	1,250,000	8,452	30	109,020	..	.....	47	165 000

* Men not returned by West Bay City.

† Tonnage not returned by West Bay City or Chicago.

SUMMARY.

Merchant and Government.....	18,000,000	15,200	45	74,666	19	117,294	56	133,000
Merchant only.....	3,900,000	6,100	13	71,989	..	.....	31	52 500
Government only.....	18,581 000	16,700	..	.....	28	216 853	21	112,000
Great Lakes.....	1,250,000	8,452	30	109,020	..	.....	47	165,000
No construction.....	1,450 000	800	..	.....	..	.....	22	67,000
Total.....	43,181,000	47,252	88	255 675	47	334,147	177	529,500

Contract price of government construction, \$88,229,460

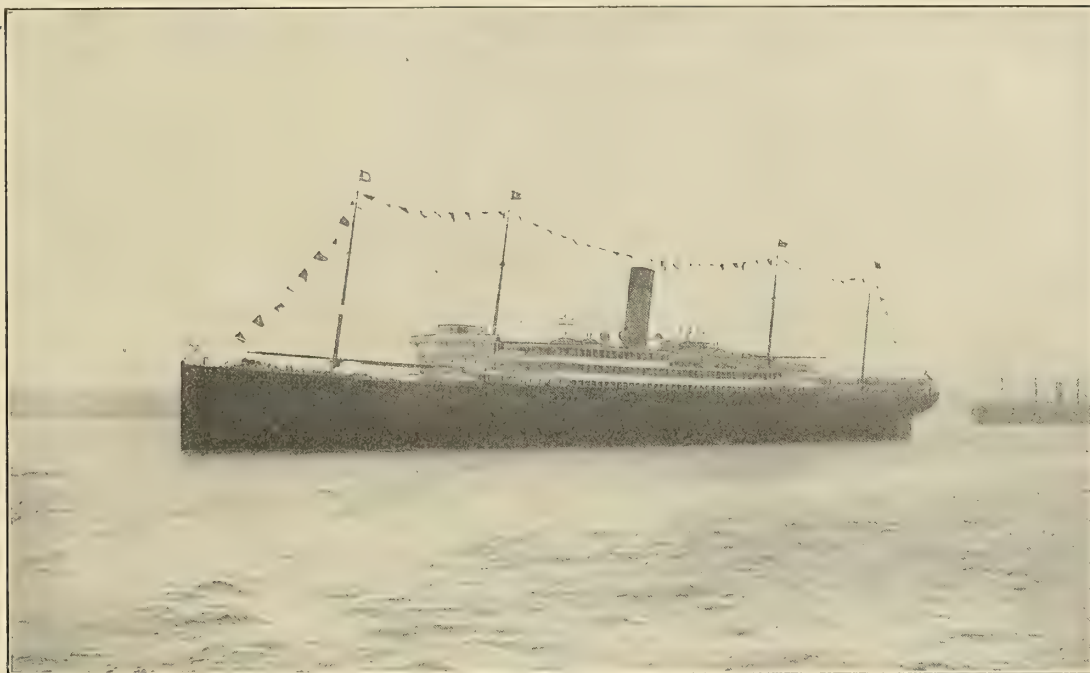
ANNUAL REPORT COMMISSIONER OF NAVIGATION.

The outlook for the coming year for shipbuilding is not in the least encouraging, according to the report of Mr. E. T. Chamberlain, commissioner of navigation, Department of Commerce and Labor. In the last annual report it was stated: "New vessels have not been ordered to take the place on the ways of large ocean steamers which have been launched, have been completed, or are nearing completion." The conditions have little changed since the time that report was written, and but five large steamers, of which four have been launched, remain unfinished. Because of lack of work the force of men in practically all the yards is being cut down, and if present conditions continue it is probable that within a few months the yards on the

STEAMSHIP ARABIC, OF THE WHITE STAR LINE.

The White Star Line has added to its service of steamers, sailing on Wednesday from Liverpool and Friday from New York, the new steamship *Arabic*, recently turned out of the Harland and Wolff yards at Belfast, Ireland. This ship was ordered by the Atlantic Transport Line, but after the merger of the steamship companies the passenger arrangements of the vessel were changed to meet the requirements of the White Star Line service, to which line the vessel was transferred.

The *Arabic* resembles in general the steamships *Cedric*, *Celtic*, and *Cymric*, though she is somewhat smaller than the first two named vessels, the length between perpendiculars being 600 feet, and the beam over all 68 feet. The other dimensions will be found in the ac-



PASSENGER AND CARGO STEAMSHIP ARABIC OF THE WHITE STAR LINE.

seaboard will be working at less than half their capacity.

From the reports received of different shipyards the tables on preceding page are given.

The total number of vessels in net tonnage, including government and merchant, in the last four fiscal years is as follows: 1900, 115 vessels, 391,009 tons; 1901, 160 vessels, 636,793 tons; 1902, 171 vessels, 617,376 tons; 1903, 135 vessels, 589,822 tons.

The names of the five unfinished deep-sea ships are as follows: *Missouri*, for the International Mercantile Marine Company, building at Sparrow's Point, Maryland, and of 7,914 gross tons. The *Minnesota* and *Dakota*, of the Great Northern Steamship Company, for the transpacific trade, of 21,000 tons, are building at New London, Conn. The *Dakota* has not been launched. The *Mongolia* and *Manchuria*, for the Pacific Mail Steamship Company's transpacific and Hawaiian service, are building at Camden, N. J., and each is of 13,500 tons gross tonnage.

companying table. The greatest difference between this ship and those of the Atlantic Transport Line is that there are no cattle carried, the space on the main deck being entirely devoted to third-class passenger accommodations, and it is in this respect that this ship attracts special attention.

There are five complete steel decks—orlop, lower, main, upper, and spar deck, the spar deck being the weather deck from stem to stern. The windlass and engine are mounted on the spar deck forward; directly aft of them is hatch No. 1; foremast; hatch No. 2 and hatch No. 3; then comes the officers' deck house, similar to that on the *Cedric*; the mainmast; hatch No. 4 and the main deck house. Each hatch is served by two winches and booms attached to the mast, or, in the case of hatch No. 3, booms are stepped on the deck at the forward side of the officers' house. This house is three decks and contains quarters for captain and officers, chart room, and above all a flying bridge with steel

screen amidships, behind which are placed the engine room and deck telegraphs, binnacle, and steering wheel. The chart room is directly aft of this screen.

On top of the main deck house is the ship's compass, set up high above deck, as will be seen in the engraving. The main house has two complete decks; on the upper promenade deck, at the forward end, is a large writing room with hard-wood floor and several mahogany writing tables and upholstered lounges. It is pleasantly lighted from a skylight above and also through square ports at front and sides; it is entered from the main hallway at the forward end of boiler-room casing; the passageway on the port side leads aft to the large first-class smoking room, which is well lighted from ports and skylights and is finished in mahogany. Fine deck space is provided on both sides, although there are three lifeboats swung along each after side of the deck from ordinary type of davits. Descending the main stairway we come to the promenade deck below. This stairway and entrance hall is finished in quartered oak, and the floor and treads are covered with large blocks of white rubber tiling. Forward of the hallway are several single-berth rooms and large toilet and bath room. The furnishing of the first-class rooms throughout is practically the same, and consists of mahogany bedstead and cabinet with large mahogany clothes press and transom seat which, in most cases, can be used as a third bed. In several of the rooms the upper berth folds up. On either side of boiler casing, running aft from the main hall, is a passage along which opens a single row of state rooms. These rooms are all practically 8 feet wide by 10 feet long, with plenty of head room and square ports with ventilator tops. The finish is white enamel paint, which, with the furnishings, make them simple but very attractive and airy. The barber shop and bar are at the after end of the house.

Descending to the main deck, the stairs land in an entryway which opens into the first-class dining saloon, fitted with three fore-and-aft tables, and short tables on either side. The dining room is lighted through large side ports and through a crystal dome in the center. The coloring of this dome is yellow and gold and transmits a most pleasing light. On the port side, aft the dining room, is the large first-class pantry, aft of which are the galleys.

On the port side is a gangway leading to the engineer's quarters and engine room, while on the starboard side are the first-class state rooms. Other state rooms of the first cabin are found at the forward end of the dining saloon. The second cabins, which are directly aft of the first cabin, are very comfortably fitted. A large dining saloon is on the upper deck, and smoking and reading rooms in the deck house above. The total accommodation for first-cabin passengers is 350 and for second-cabin is 200.

As previously stated, the third-cabin quarters are of special interest, extending practically the full length of the ship. Most of the berths are arranged in two-, three-, and four-berth rooms, fitted with mattresses, sheets and blankets, washstands, etc. A large dining room is located amidships, with tables and separate chairs. Fresh air is supplied for main cabin and passageway by a complete system of mechanical ventilation, consisting of air ducts and Sirocco fans.

Between the two deck houses is a large hatch, and the after holds are reached by three other hatches. At the stern are a steering-wheel house and warping capstan. The steering gear is of the Wilson and Pirrie type, consisting of two duplicate sets of heavy double-inverted, direct-connected engines mounted parallel to each other and to the keel. One set is always held in reserve and can be geared to the quadrant by moving it on its foundation. A telemotor controls the valves, which are of the piston type.

The general appearance of the engine room is similar to that of other ships turned out by this famous yard at Belfast. There are two sets of four-cylinder, quadruple-expansion engines, the arrangement of the cylinders being best suited to reduce vibration. From forward aft the order of cylinders is: high-pressure, second intermediate, low-pressure, first intermediate. The valves of the adjoining pairs of cylinders are on the outside. The distances between centers of cylinders are as follows: H. P. to second I. P., 8 feet 5 inches; second I. P. to L. P., 14 feet 3 inches; L. P. to first I. P., 8 feet 5 inches. All cylinders and pistons are fitted with liners. The cylinders are supported on cast-iron columns front and back, braced at the top by a cast-iron box girder, while the tops of cylinders are steadied by wrought-iron braces. The condenser is built in the back of the two aft engines, and the air and bilge pumps are

NAME—Arabia. LAUNCH—D—1903.		NATIONALITY—British. BUILDER—Hafland and Wolff.		TYPE—Passenger and freight. OWNER—White Star Line.	
Length between perps		Boilers, Scotch.		4 single end, 4 double-end	
Breadth		Diameter		14 ft. 5 ins.	
Depth		Length		single-end, 11 ft. 10 "	
Gross tonnage		Tubes, diam.		double-end, 19 " 10 "	
Cargo capacity		" number, single-end, 370; double-end, 740		2 1-2	
Load draft		" length over all, single-end, 7 ft. 6 ins.		double end, 7 " 11 "	
Displacement		Furnaces, mean diam.		42 "	
Engines: Number		" number each		single-end, 3 double-end, 6	
Type		Length of grates.		...5 ft.	
Cylinders, diameters		Howden forced draft.		single-end, 2,169 sq. "	
Stroke		H. S., each		double-end, about 2,200 "	
I. H. P. at sea		" total about		26,370 "	
Revolutions at sea		G. S., each		single-end, 52 "	
Boiler pressure		" double-end		104 "	
Shafting, crank line		G. S. total		644 "	
" thrust		H. S. + G. S.		408 "	
" propeller, mean		I. H. P. + G. S.		153 "	
Propellers		H. S. + I. H. P.		263 "	
Diameter		two, 3 blades each		18 ft. 6 ins.	
Pitch		18 ft. 6 ins.		23 " 6 "	
Area, developed, each wheel		.84 3-4 sq. ft.			

operated from links taken from the first intermediate crosshead.

Dimensions of the cylinders are as follows: high-pressure, 30 inches; first intermediate-pressure, 43 inches; second intermediate, 63 inches; low-pressure, 89 inches; common stroke of 5 feet. The length of connecting rods between centers is 8 feet. The thrust is taken up by eight collars of the horseshoe type between the rings of the thrust shaft; the outside of the latter over the collars is 28 1-4 inches, the diameter between collars is 17 3-4 inches. The line shaft is in seven lengths and 17 inches in diameter. Propeller shaft is 18 1-4 inches at the after end and 18 3-4 inches at the forward end, and fitted with a brass sleeve in several lengths.

Weir pumps are installed at the forward end of the engine room; there are also an auxiliary condenser, two evaporators, and distiller. The usual outfit of bilge, water, sanitary, fire service, etc., pumps are installed. In a recess in the bulkhead above the thrust shafts is the dynamo room, in which are placed three sets of Allen compound engines direct-connected to generators running at 256 revolutions; the voltage is 100, and 600 amperes. A closed feed-water heater is placed in the upper engine room.

The boiler equipment consists of four double-end and four single-end Scotch boilers fitted with Howden forced draft. They are placed in two stokeholes, the four double-end boilers being mounted abreast of each other and aft of the single-end boilers. The coal is carried in athwartship bunkers. The diameter of the boilers is 14 feet 5 inches, the length of the single-end 11 feet 10 inches, and the double-end 19 feet 10 inches. There are three furnaces in each single-end boiler and six furnaces in each double-end boiler, each furnace having its separate combustion chamber. There are 128 tubes in the center nest and 121 in each of the wings; all tubes of the single-end boilers are 7 feet 6 inches and those of the double-end 7 feet 11 inches long, outside diameter 21-2 inches. The mean diameter of the Morison furnace is 42 inches; the length of grates is 5 feet. The propellers are of steel with three manganese-bronze blades.

Saving Overprinted Blueprints.

The following simple method of saving burnt blueprints and prints made on old paper appeared in the *American Machinist*:

"The process, if it can be so called, depends on the fact that a print which is washed but a very little, say about half a minute, or just enough to bring out the blue, will, if exposed to sunlight while wet, bleach out, and that in a very few minutes. By watching it the lines can be brought out white and clear while the blue ground is not sensibly affected. After the lines have been brought out to the desired clearness, put the print back in the water and wash it as a properly exposed print would be.

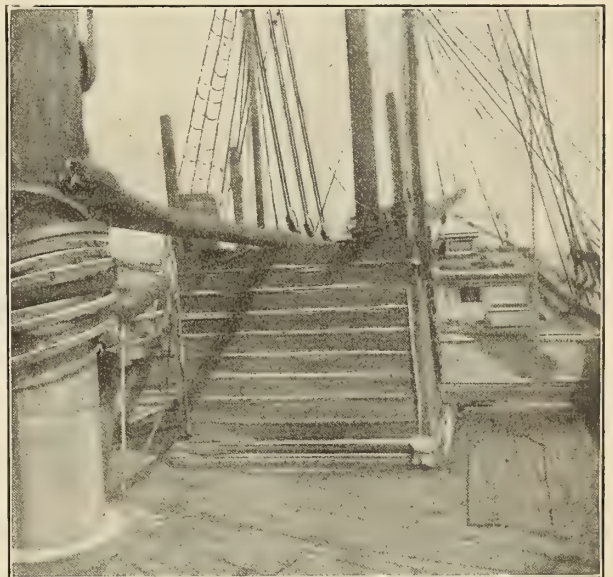
"This method is particularly handy for prints on old paper, as it sometimes happens that a print is wanted, but no paper is at hand except some that will not make a readable print. By printing the old paper about the same as if it were fresh and then bleaching in sunlight a very fair print can be secured.

"J. J. EWING."

The Ill-fated Cactus.

A correspondent sends us the accompanying deck view of the American schooner *Cactus*, which ran ashore on the upper Washwoman Reef on the coast of Florida. The schooner was loaded with coal bound for Key West. Considerable sea was running at the time and twelve hours after stranding the vessel was rapidly filling; a tug came to her assistance, but the water was too rough to allow coming alongside. For a month the *Cactus* remained ashore, favored by calm weather, and was then sold with her cargo for \$580. Her purchaser went to the wreck and, after a month's work, pumped the vessel out and towed her to Key West, where he sold her for \$8,000.

Temporary repairs were made by hauling the *Cactus* out on a marine railway, and she set sail for Jacksonville for permanent repairs about the first of March.



COFFERDAM OVER HATCH FOR RAISING THE CACTUS.

About sixty miles from Key West she started to leak so badly that the captain brought her about and headed for Key West again, while the crew pumped night and day to keep her afloat. Two hours after she reached harbor she sank in 38 feet of water with a list of 45 degrees, leaving her weather rails just above water.

The work of raising the *Cactus* was much more difficult than at the previous time. The contractor took a scow alongside the schooner and built a cofferdam the same size as the midship hatch, 12 by 8 feet. The cofferdam was built of posts 4 by 4 inches and sided with 11-2 by 12-inch planks battened with canvas. The posts were 2 feet longer at the bottom than the planking, so that they would go down inside of the hatch. A beam was lashed from the mainmast to the mizzenmast, and from this with blocks and fall the cofferdam was hoisted up and lowered down into the hatch and a diver battened it to the deck. The *Cactus* was then pumped out in ten hours with a 6-inch centrifugal pump and taken to the railway for repairs. A month later she sailed for Mobile, Ala.

BOILER DESIGN.

BY H. K. SPENCER, U. S. R. C. S.

The power necessary to drive a hull of given size and form at a given speed having been determined by one of the usual methods, the next consideration is the type of machinery to be used in producing that power. It does not follow that because a certain type of engine is most economical in the consumption of steam and fuel that it is always the best one to install, and that it will prove the most economical when all the conditions of the problem are considered. Interest on the cost of the installation is always an item; the cost of fuel and the cost and quality of labor are also considerations.

Where fuel is cheap and labor not only cheap but poor, machinery of the simplest type should be selected, as it is not only the best under the conditions, but the cheapest in the long run, as the interest on the higher-priced machinery and its rapid deterioration under cheap and poor attendance would more than outweigh any considerations of fuel economy. The commercial considerations are really the governing ones, and cannot be ignored to secure any of the many economies which can be obtained by the expenditure of money. For a vessel that is to make long voyages, the quantity of fuel that must be carried will be a considerable part of the total carrying capacity of the vessel; and as the cost of carrying fuel to the exclusion of cargo has an important bearing on the profits of the voyage, the selection in this case would be machinery of high economy. For any vessel, in whatever service, positive certainty of continuous running is an essential in the machinery.

The weight of the machinery itself must be considered. It has been determined that a certain power will be required to drive a given ship at a given speed; steam pressure and the degree of expansion to be used have been fixed upon, and, with these fixed, the necessary power can only be obtained with a certain piston displacement, which means either a large slow-running engine, a small fast-running engine, or a compromise between the two.

To illustrate, an engine such as is used in torpedo boats, to develop on trial 1,800 I. H. P., would have a piston speed of about 1,200 feet per minute, and the mean effective pressure referred to the low-pressure cylinder would be about 46 pounds. The diameter of the low-pressure cylinder must then be 37 inches, or if divided into two cylinders, as is usual, then each will be 26 inches in diameter, and would be given a stroke of 18 inches, which would make the engine run at a rotative speed of 400 revolutions per minute. An engine in a merchant steamer developing the same power would be run at a piston speed of about 700 feet per minute, which, with an equivalent mean effective pressure of 35 pounds referred to the low-pressure cylinder, would require a cylinder 56.5 inches in diameter; it would be given a stroke of 42 inches, which would make the engine run at 100 revolutions per minute.

The engine with a piston speed of 700 feet per minute would weigh about 175 pounds per I. H. P., while the torpedo-boat engine would weigh about 25 pounds per

I. H. P., which makes the ratio 7 to 1. Scotch boilers worked with natural draft would weigh something like 200 pounds per I. H. P., with moderate forced draft about 150 pounds per I. H. P.; water-tube boilers under natural draft about 120 pounds per I. H. P., with moderate forced draft about 85 pounds, and with an air pressure of 4 or 5 inches of water, such as is used in torpedo boats, about 28 pounds per I. H. P.

The allowable draft of the vessel often limits the weight of machinery. When the vessel is to run in shallow water and screw propellers are to be used, the light, quick-running engine must be adopted. For ordinary service the engine of moderate piston and rotative speeds should be selected from considerations of durability, minimum repairs, etc. Without the use of water-tube boilers, it cannot be said that the use of quadruple-expansion engines makes a saving in the total weight of machinery, because of the increase in weight caused by the heavier boilers necessary for the increased pressures which are essential to the economical working of such engines.

The comparative economy of quadruple, triple, compound, and simple engines is well known, and, having decided to what extent it is advisable to carry fuel economy, the selection of the type of engine can be made. Suppose that in a certain case 1,800 I. H. P. is required, and that it has been decided best to use an ordinary three-cylinder triple expansion engine with moderate piston speed, and that the boilers are to be the Scotch type worked under natural draft and built for a working pressure of 160 pounds per square inch.

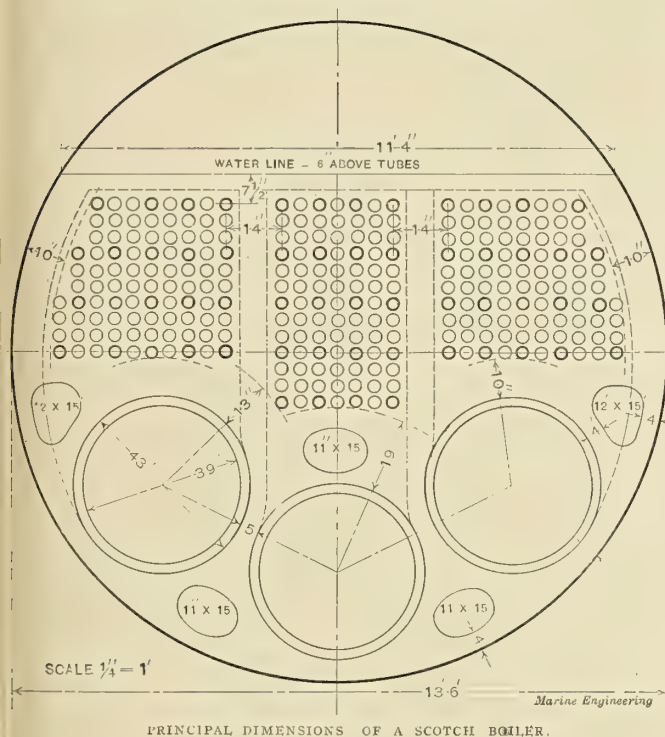
It can be assumed that the engine to be installed will not consume more than 15 1-4 pounds of steam per I. H. P. per hour, so that the boilers must be able to evaporate $1,800 \times 15 \frac{1}{4} = 27,400$ pounds of water per hour. With the boilers kept clean, as they should be, it is safe to assume that each pound of coal burned on the grates will evaporate 9 pounds of water, therefore there must be sufficient grate area to burn $27,400 \div 9 = 3,044$ pounds of coal per hour. With a smokestack of not unusual proportions, 16 pounds of coal can be burned per hour per square foot of grate, so the grate area necessary is $3,044 \div 16 = 190$ square feet.

This grate surface can be provided in a number of ways: first, in one large double-end, eight-furnace boiler; second, two large single-end, four-furnace boilers; third, three moderate-size single-end, three-furnace boilers; or, fourth, in four single-end, two-furnace boilers. It would not be wise to depend solely on one very large boiler for steaming, so, aside from the advantages of dividing the boiler power into two or more units, the space occupied will have to be considered, as that has much to do with the arrangement and capacity of bunkers.

In the first, second, or the fourth combinations, where there are eight furnaces in all, each furnace would be given a grate area of 23.75 square feet; the grates would be 61-2 feet long, so the furnace flue should be 3.65 feet internal diameter, and a corrugated furnace of 44 inches least internal diameter would be used. In the three-furnace boilers each of the nine grates must have an area of 21.1 square feet; with 61-2-foot grates each boiler would require three

corrugated furnace flues of 39 inches least internal diameter.

Experience or observation should tell the designer that a shell about 16 1-2 feet in diameter is necessary to accommodate four 44-inch furnaces, so it is assumed for the present purpose that the double-end and large single-end boilers would be 16 1-2 feet diameter. In the same way it is known that the three- and two-furnace boilers would be about 13 1-2 feet and 11 1-2 feet in diameter, respectively. The lengths of the boilers would be about 20 feet for the double-end and 11 1-2 feet for the single-end. Making allowance for fire rooms, the double-end boiler placed fore and aft would occupy at least 38 feet of the length of the vessel, so it will be considered that with any arrangement that length is given up to boiler and bunker space.



Suppose the general dimensions of the steamer are length 290 feet, beam 45 feet, depth 21 feet, then the plan of the space allotted to boilers and bunkers can be drawn to scale as a rectangle 46 feet by 38 feet. An average height of at least 15 1-2 feet could be obtained for the bunkers. Trying the different boiler arrangements in the rough scale drawing, it is found that with the double-end boiler two side bunkers with a total capacity of about 350 tons could be arranged; with the two large single-end boilers, two side bunkers and one athwartship bunker with a total capacity of about 340 tons; with the three single-end boilers, two side bunkers and two bunkers forward of the fire room, connected by a small athwartship bunker, with a total capacity of about 320 tons; and the four boilers permit an arrangement of two side bunkers connected by a small athwartship bunker, with a total capacity of about 300 tons.

The large double-end boiler would give somewhat less weight than any of the other arrangements, and

two boilers would give a slight advantage in that respect over either the three- or four-boiler arrangements. Considerations of space occupied fore and aft recommend the use of the two large boilers, but smaller boiler units seem to be desirable. The use of three boilers gives good bunker space, and boilers of moderate size built of plates of moderate thickness. With four boilers, the subdivision of boiler power is carried still further and the plate thickness further reduced. They would prove very satisfactory in operation, but from considerations of weight, cost, convenience in operation, etc., it is decided best to use the three boilers of moderate size.

It now remains to distribute the proper amount of heating surface, which includes the effective surfaces of the furnaces, combustion chambers, and tubes. A proper volume of steam room and area of water surface must be assigned, and it must be seen that there is a sufficient volume of furnace and combustion chamber above grates to insure proper combustion. The area of water surface is usually measured at a height six inches above the highest tubes, so when that has been determined, the height to which the tubes can be carried is also determined. Two square feet of water surface per square foot of grate area is a fair allowance, which gives to each of these boilers an area of water surface of 126 square feet when the water is 6 inches above highest tubes.

It is now necessary to make a scale drawing of the boiler in cross-section showing the arrangement of furnaces and tubes. It is known that the boiler should be about 13 feet 6 inches in diameter and about 11 feet 6 inches long, so for a first trial these dimensions will be used to see if they are suitable to permit of a proper arrangement of furnaces and tubes with sufficient steam room, room for cleaning, etc. It is assumed that the above are inside dimensions. The area of water surface, 126 square feet, divided by the length of boiler, 11.5 feet, gives 11 feet, which to represent the water level should be drawn as a horizontal chord to the circle in the figure, whose diameter is 13 feet 6 inches, and another horizontal line 6 inches below it will represent the height to which the tubes can come. Three-inch tubes will here be used, as they are generally considered good size; 2 3-4-inch tubes are also largely used. The furnaces should be separated from each other and from the shell by about 5 inches.

The greatest external diameter of the furnaces will be 43 inches, so the circles representing them are drawn that diameter. The tubes should be spaced horizontally, so that they are separated by about one-half their diameter, vertically. An inch space is sufficient with 3-inch tubes, which will make the spacing of the tubes 4 1-2 inches between centers horizontally and 4 inches vertically. Sufficient space, about 10 inches, must be left between the tubes and the shell and between the nests of tubes to enable an ordinary man to work down to the furnaces and remove any deposits. Each furnace has its separate combustion chamber. Accessibility for cleaning will not only make it possible to maintain the efficiency of the boiler, but to prolong its life. The water side of the furnaces, particularly, should be easy of access for cleaning and inspection. Giving the above matters due consideration,

the arrangement in the drawing is the result, which shows that a shell 13 feet 6 inches in diameter is just about right.

Allowing 2 feet 6 inches for depth of combustion chambers and about 7 inches for the water space between combustion chambers and back head, the length of tubes, if the boiler is to be 11 feet 6 inches inside heads, will be 8 feet 4 inches inside tube sheets; the length of the furnaces will be the same. The heavy circles among the tubes indicate stay tubes, which would have a thickness of about 1-4 inch. From these data and the drawing the results given below were obtained for one boiler:

Steam pressure	160 lbs.
Diameter of shell	13 ft. 6 in.
Length of shell, inside heads	11 ft. 6 in.
Number of furnaces	3
Inside diameter, least	39 in.
Grates, length	6 ft. 6 in.
Grate area	63.6 sq. ft.
Diameter of tubes, outside	3 in.
Number of tubes, total	275
Number of stay tubes	58
Length of tubes, inside tube sheets	8 ft. 4 in.
Heating surface, tubes	1,800 sq. ft.
Heating surfaces, furnaces	134 sq. ft.
Heating surface, combustion chambers	204 sq. ft.
Total heating surface	2,138 sq. ft.
Cross area of tubes for draft	11.15 sq. ft.
Area of water surface 6 inches above top, tubes	130.3 sq. ft.
Steam room	279 cu. ft.
Volume of furnaces and combustion cham- bers above grates	273 cu. ft.

Ratios:

Tube H. S. ÷ G. S.	28.66
Furnace H. S. ÷ G. S.	2.13
Combustion chamber H. S. ÷ G. S.	3.25
Total H. S. ÷ G. S.	34.04
Tube H. S. ÷ total H. S.	.842
Furnace H. S. ÷ total H. S.	.063
Combustion chamber H. S. ÷ total H. S.	.095
Cross area tubes for draft ÷ G. S.	.177
Water surface ÷ G. S.	2.07
Steam room ÷ G. S.	4.44
Volume of furnace and combustion cham- bers ÷ G. S.	4.35

In marine boilers the ratio of total heating surface to grate surface varies from 25 to 40, with 30 a very common ratio; but where the rate of combustion is above the ordinary, it is best, for the sake of fuel economy, to exceed 30, the ratio obtained with the length assigned to the boiler under consideration being about right for the rate of combustion to be maintained.

All the principal dimensions, ratios, etc., for the boiler have now been determined, and the next step is to calculate the riveted joints and the staying of the flat surfaces, a subject which will be treated later.

(To be continued.)

MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, NEW YORK.

The forty-eighth annual meeting of the American Society of Mechanical Engineers takes place in New York December 1 to 4. Owing to the increased attendance at these meetings it has been decided to hold some of the sessions in larger halls. On Tuesday and Friday the professional sessions will be held at the society's headquarters, 12 West Thirty-first street; on Wednesday, in the hall of the Mendelssohn Union; and on Thursday at the Stevens Institute of Technology, Hoboken. The annual address of the president, Mr. James M. Dodge, will be delivered on Tuesday evening, and the subject is "The Money Value of Technical Training." On succeeding days the papers taken up are to be as follows:

"The Pitot Tube," by W. B. Gregory.

"Method of Determining Rates and Prices for Electric Power," by F. B. Perry.

"Three- and Four-Wire Multiple Voltage Systems," by Louis A. Gillet.

"Test of a Compound Engine Using Superheated Steam," by D. S. Jacobus.

"The Pressure Temperature Curve of Sulphurous Anhydride (SO₂)," by E. F. Miller.

"Construction and Efficiency of a Fleming Four-Valve Engine," by Benj. T. Allen.

"Compact Gas Engine; Beam Type," by C. H. Morgan.

"Standard Unit of Refrigeration," by J. C. Bertsch.

"Series Distilling Apparatus of High Efficiency," by W. F. M. Goss.

"Air Motors and Air Hammers, Apparatus and Methods for Testing," by Max H. Wickhorst.

"Valve Motion of Duplex Air Compressor," by S. H. Bunnell.

The social feature of the session will be a reception and *conversazione* at Sherry's on Thursday evening, and on Wednesday afternoon parties are to be arranged for visiting the power stations in New York city. Thursday afternoon will be spent in viewing the laboratory, shops, and drawing rooms of Stevens Institute, and on Friday afternoon the De Laval Steam Turbine Company will form an excursion to visit its works at Trenton, N.J.

Oil-Burning Steamers on the Pacific Coast.—Permits have been granted by the United States Inspector of Steam Boilers at San Francisco to use oil on 123 vessels with a total registered tonnage of 100,437 tons. These vessels are of all classes and sizes from harbor boats to large ocean steamers.

Supervising Inspector-General's Annual Report.—Mr. George Uhler, supervising inspector-general, has submitted his annual report of the Steamboat Inspection Service. No mention is made of the proposed changes of the law and the revision of the rules and regulations as to the result of the special session of the Board of Supervising Inspectors at Washington in June last. These recommendations have been submitted to the Secretary of Commerce and Labor. A decreasing number of violations of the law are reported, owing to the department imposing the fines for such violation. The total number of accidents of all kinds, mostly resulting in loss of life, during the fiscal year, was only forty-nine, of which four were caused by boiler explosions.

Revival of Our Shipping.

In commenting upon the article and letters which appeared in the November number of *MARINE ENGINEERING* concerning the shipping question, Professor Trowbridge, of Columbia University, has written to the *New York Sun* on some of the conditions which tend to make the cost of building and operating American ships higher than those of other nationalities. Means of remedying these two conditions he gives in part as follows:

"One advantage that could be given to ships built in this country would be to put an export duty on coal and have this duty apply to all coal supplied to any foreign-built ship, and not to coal supplied to American-built ships registered here. This would be a source of revenue to the government and not an expense, as a subsidy would be. Such a duty would not be unjust, as it would merely be a case of charging the foreigner a certain amount more than our own people were charged for some of the mineral produced here. This duty would be especially beneficial to the large, swift steamer which uses such great quantities of coal, but not at the expense of the freight ship, as the latter would have an equivalent advantage over any foreign-built vessel of its own class.

"The price of an American-built ship is from 25 to 75 per cent. higher than for a similar ship built in Great Britain, depending largely on the type of vessel. Why this is so is usually explained by the greater cost of labor here than abroad. There is good reason to doubt, however, that the blame should be placed on the cost of labor. Certain it is that American labor is well paid, but it is not better paid in shipbuilding than in the two industries that employ exactly the same kind of labor, namely, bridge building and locomotive building.

"In any large shipyard the organization is naturally separated into two divisions of hull department and engine department. The work of the hull department is exactly parallel to that of a bridge-building concern, and the work of the engine department to that of a locomotive works. Of course, there are peculiarities in hull work not involved in bridge building, such as bending the frames and the great amount of warped surface on a ship, but on the whole the two are practically parallel. Likewise, there are differences in the engines and auxiliaries used on a ship from those on a locomotive, but in the main features of manufacture they are parallel.

"It has been shown that American bridge builders and American locomotive manufacturers can undersell English and European manufacturers of the same goods. Such being the case, what is the reason the American shipbuilder, who uses the same kind of materials and employs the same kind of labor, cannot undersell his foreign competitor?

"There is a simple, definite answer to the question, and it is that the American shipyard is not operated as economically as either the bridge or locomotive shop, because it is not as well organized and conducted. The principal reason for this is not the lack of brains or effort on the part of the men at the head of the shipyards, but because the effort exerted has been to cheapen the product rather than to lessen the cost of producing it. In almost any of our American shipyards the ex-

pense of the office and drafting rooms could be easily reduced to one-half what it is at present. If the shops and yard were looked after more carefully, and a proper system of piecework introduced, it is safe to say that almost as large a reduction could be made in the expense of these departments. It is because of their efficient organization that the large British shipyards are able to do work so cheaply, and not altogether because of the low wages they pay.

"Let Congress give the American-built ship enough advantages to compensate for the higher cost of operating American ships, due to our shipping laws, and the merchant marine of the United States will take care of itself."

The above letter called forth a reply from Mr. Alexander R. Smith, superintendent of the Maritime Association of the port of New York, and, while heartily agreeing with Professor Trowbridge that the American ship must be protected in some measure by legislation, he points out that it is impossible to build ships and their engines along similar lines as used for locomotive and bridge building. He states in part as follows:

"The building of locomotives and bridges in the United States is a great, permanent industry. With our 200,000 miles of railroads—nearly equal, I believe, to that of all the rest of the world—the demand for locomotives and bridges is enormous. Moreover, they are standardized to a degree quite impossible in the construction of hulls and marine engines. The wonderful efficiency of our locomotive and bridge builders is due to the perfection of their system of construction, the regularity and stability of orders, and upon an enormous scale; a condition that does not in any degree approximate in the building of hulls and marine engines, where the demand is infrequent, spasmodic, fitful, and intermittent. The ship and engine building establishments must be ready to take contracts at all times, thus entailing fixed charges that bear very heavily upon the small product that is turned out, and which accounts for the comparative high prices of our ships and engines. In bridge and locomotive building these fixed charges are distributed over a product so large as to make the cost extremely low.

"Let the demand for American-built ships once be created and steadily maintained, as it so long has been for locomotives and bridges, and I am able to assure you that the cheapness and effectiveness of American-built ships will compare quite favorably with that of those built abroad, as the cheapness and effectiveness of American locomotives and bridges compare with those of foreign construction.

"How to create the demand for American-built ships is the all-absorbing problem—that is the kernel of the nut that has got to be cracked. Whether it will be by subsidies, or bounties, or by differential tonnage and tariff dues, or by export duties or bounties, I am unable to say; but of this there is no doubt: the American people will never be satisfied until the problem is solved, and the friends of American shipping welcome the discussion of the subject by all who, like Prof. Trowbridge, declare themselves in favor of American-built ships. The more the subject is discussed, in the spirit of inquiry and patriotic interest displayed by Prof. Trowbridge, without prejudice against, but rather in favor of, American-built vessels, the nearer we approach a discovery of a method at once practicable and effective."

Positions Vacant.—The United States Civil Service Commission announces that examinations will be held on December 15 and 16 at large cities throughout the United States for the following two positions: First, assistant steam engineer, at a salary of \$720, in the War Department; second, position of local and assistant inspector of boilers at Portland, Me., at a salary of \$1,800 per annum. All persons desiring to compete should at once apply to the U. S. Civil Service Commission, Washington, D. C., for proper application forms.

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Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

IT is seldom, indeed, that these columns are devoted to politics, and yet, as the events which have taken place in our state and national affairs in the last few weeks portend to bear most beneficial results to our present demoralized and more or less inactive shipbuilding industry, we present them to our readers. Citizens throughout the country are evidently becoming better posted concerning the condition of our merchant marine. Through the efforts of the New York Board of Trade and Transportation, the Home Market Club, of Boston, and others, the facts of the present condition of American shipping have been forcefully brought before our citizens. The general discussion of the question has taken place in the daily press throughout the country, and editorials are to be found in practically every inland paper dealing with the question at large or with the benefits that a special section of the country would derive if our commerce were more generally carried in American ships. The results of this campaign of education carried on through the above-mentioned agencies are shown in no uncertain way.

The election in Ohio of a Republican legislature by an overwhelming and unprecedented majority means more than a victory for that party in the state election. Every voter knew perfectly well that if a Republican legislature were elected it would return Senator Hanna to the United States Senate. It was Senator Hanna who made such a strong fight for subsidy in Congress. His record on this issue was most bitterly attacked by his opponents in this campaign, but he reiterated his belief in the necessity and principle of protecting American ships, and stated in every public address that if he were re-elected he would again take up this issue and not be content until he had succeeded in obtaining from Congress necessary legislation. The overwhelming verdict in favor of this principle, coming as it does from the inland state of Ohio, may readily be looked upon as a sign of the times.

In New York State, by a majority of about two hundred thousand votes, the citizens decided in favor of building a one-thousand-ton-barge canal from Buffalo to the Hudson, although they thereby entailed upon themselves a prospective outlay of over one hundred million dollars. They considered this a small amount in view of the increased commerce which will be brought into the state by the new canal. This will require a new type of canal boat and should bring much work to the yards of Lake Erie and New York harbor.

The establishment, and recognition by this country, of the new-born Republic of Panama has settled for all time the question of a trans-isthmian waterway and the part in which this country is to take in it. Our government will now construct the Panama canal, and that right speedily, so that within a few years we may expect to see this great waterway open for commerce. It is reasonably anticipated that this will be immediately followed by an immense expansion of trade between our Pacific and Atlantic states, and a new field of commerce will be opened for merchants on the western coast of South America.

Although the present conditions in shipbuilding are most deplorable, yet the indications as we look ahead into the near future are, in our opinion, more auspicious for increased and continuous work than in the past many years. The failure of the Shipbuilding Trust should be looked upon with satisfaction now that it is past, rather than with regret. The organization, as has been most clearly brought to light through recent investigation, had neither excuse nor possibility to

live, overcapitalized as it was and organized with a most barefaced purpose to defraud the public. Its collapse has clarified the atmosphere of suspicion and uncertainty, and the industry may now develop along natural lines with the assurance that never again, at least not until the memories and history of this monumental scandal have been forgotten, will it be subjected to the stock manipulators' designs. The public have seen and felt the over-capitalizing folly and learned the lesson. The conditions of trade throughout the country seem to be improving; the crops—the real wealth of our nation—are enormous, and railroads are reporting increasing earnings. So it is that we may look forward with a degree of certainty to the healthy growth of our shipbuilding to meet the increasing demands of foreign trade under the protection of wise legislation.

THE annual meeting of the Society of Naval Architects and Marine Engineers may be looked back upon by the attending members as full of interest, for considered as a whole the papers read were good and elicited some interesting and valuable discussion. Upon the preceding pages of this issue we give abstracts of the papers, and the resulting discussion but slightly abbreviated, and recommend its careful perusal to our readers. The first paper on the trial of a ferryboat is not only of general interest as dealing with a comparatively new class of boat, but also of most timely interest in view of the prospective contract by the City of New York for five high speed ferryboats for the Staten Island service. There is but scant similarity between the new ferryboat in point of design, construction, arrangement and powering and her side wheel predecessor. These boats hold a most important part in our transportation systems, especially in and about the harbor of New York. Most of the railroads which operate ferry services are replacing the side wheeler with steel boats equipped with screws. Colonel Stevens was the first to apply this system of propulsion to the ferryboat, and its success is shown by the fact that all the new boats are built on this line. As the boats have screws at either end, the bow screw has introduced a new and undetermined factor in this already complex problem of screw propulsion. Shipbuilders have really done little to ascertain the best form of hull and propeller for this class of work, and the investigations of the author of this paper, taken with those already pub-

lished by him on this subject, prove valuable additions.

The paper on steam piping and especially the resulting discussion contain some good points on a subject which to the present has been given but scant care. A leaky joint, a split coupling or fitting, a burst steam pipe are some of the frequent incidents that the marine engineer has to contend with because of the faulty design either in the fitting itself or in the lay-out of the piping which does not allow for expansion. Thus repair work done at sea has to be done under the most trying conditions. The substitution of steel for copper in high steam pressures is shown to be a step in the right direction. A third paper, illustrating the advance made in materials entering into the construction of boilers, is given under the heading of non-corrosive nickel steel boiler tubes. The life of this tube is stated to be two and one-third times that of the usual low carbon steel tube. At the same time the reduction in weight is considerable, amounting to many tons in a high powered ship, more than offsetting the increased first cost and decreased cost of maintenance.

Much of the second day's session was devoted to the subject of launching both large and small ships, and the members did not hesitate to give out the data of these calculations as well as in some cases that of the ships themselves. In some of the papers and discussions there was more or less of a personal element entering in, but fortunately the bulk of the matter is as it should be, strictly professional. The theoretical side of naval architecture was duly represented in several papers presented, three of which were in the line of shortening the work of calculations of a ship's form. The one by Mr. Taylor should be looked upon as a long step in advance in deducing formula for laying down the lines of ships. This work, the result of an extended series of investigations at the experimental tank in Washington, contains most valuable data for the naval architect. Other good papers were presented, but limited space does not permit mentioning here, and of the poor ones which were unfortunately included, we pass without comment.

Taken as a whole, we may look upon the meeting as another step in the advancement of the art of shipbuilding with an increased disposition on the part of the members to give out their personal data which they have been accumulating, for the good of the Society.

An Oiler's First Experience, or the Practical Side of Marine Engineering.

BY ALBERT R. EMMONS.

Having worked in the engineering department of a number of ocean steamers and also served as stationary engineer on shore, I know by comparison how hard and really full of danger the marine engineer's life is. I well recollect my first oiling experience at sea. I had been working at stationary engineering for a number of years, yet always had a taste for the water, having traveled at sea considerably as a passenger and not being affected by seasickness; so, when the opportunity came, I shipped as oiler on a mail-fruit steamship running between Boston and Jamaica. She was 2,104 tons gross, with an average speed of about 14 knots. There were two single-ended Scotch boilers, fitted with Howden draft and having a total of eight fires. The engines were triple-expansion, twin-screw, three-cylinder, three-crank, vertical-inverted, direct-connected, fore-and-aft, double-bar Stephenson-link motion of 3,000 aggregate horse power, turning up 125 revolutions. There were also two blower engines, two air pumps of the twin-cylinder beam type, two circulators, two dynamo engines, steam steering gear, and about a dozen duplex pumps of all sizes, for bilge, sanitary, feed, ballast, fresh water, etc. All this machinery was crammed into a small engine room, where every square foot of room was utilized. We carried four engineers, six oilers, nine firemen, three coal passers, and a cadet engineer. They represented about a dozen different nationalities.

We left Boston about 7 P.M. September 13. I was in the 8-to-12 watch, and came down into the engine room ahead of time to get initiated. We had just backed out of the dock amidst a din of whistles, clanging of telegraphs, and multiplicity of orders. Most of the engineers and oilers were on duty and there was lots going on. Engines were worked ahead and astern, steam was escaping, auxiliary machinery pounding, and water flying. Soon the port air pump stopped; while, at the same time, a link end got warm on the port engine, which was immediately followed by a message down the speaking tube that the steering gear would not work. Here was trouble right off. The chief was yelling and bawling out orders from the top platform, the first assistant was trying to start the port air pump, and the second was doctoring that link end. To add to this, the dynamo began to race and the bilge pump would not suck water. Strange to say, in a few minutes everything was straightened out, but in such a cool, dare-devil fashion that I was hugely surprised. They have such quick ways of doing things in a marine engine room!

Soon after this we were outside Boston Light, going ahead with everything wide open. How is it possible to describe the confused mass of flying rods, accompanied by the most infernal racket? The air seemed to be full of cranks, crank pins, connecting rods, piston rods, shafts, thrust bearings, links, valve stems, eccentrics, eccentric rods, cylinders, blowers, circulators, dynamos, pumps, steam, hot water, cold water, oil, grease, copper pipes, fearful profanity, and the most infernal, terrible, whackety-bang thunder, that I be-

lieve it would scare the devil himself. It seemed as if forty boiler shops were all condensed together.

Everybody had knocked off except the regular watch. The third assistant was in charge, with myself and another oiler; I looked after the port engine and all the auxiliaries on that side. It was necessary to put one's hands into all sorts of dangerous places to feel the different bearings. This is dangerous work; but one gets used to anything in this life.

Pretty quick the feed-water heater up overhead overflowed, and down upon us fell an awful shower of terribly hot water. The other oiler rushed under and speeded up the feed pump, accompanied by the most horrible execrations from the engineer of the watch. Next the bilge strainers got choked, and, the first thing we knew, all six cranks picked up the water and shot it all over the place. This called forth hair-raising adjectives and nouns from the third assistant (whom we will call "Nidgren"). In a voice which sounded like a circular saw when it first bites into a big log, he ordered me to clear out the starboard bilge strainer. I had to reach halfway down into a hole 20 inches square, out of which a lot of pipes emerged (some of them pretty hot), to get at the strainer. Within a foot of my head the flywheel of a blower was revolving at 800 revolutions per minute. It was very fatiguing, holding on with one hand and taking out ashes with the other. At one time the water was so high that I had to put my head under.

The voltage on the dynamo next began to work up and down between 80 and 140 volts. This was adjusted by using the throttle. The governor evidently did not work as it should. Then the port air pump got stuck again, dropping the vacuum down to 5 inches before any one noticed it. Nidgren could not start it at first, so he opened a valve, which allowed the other pump to work on both condensers together. After numerous prying with a pinch bar, screwing of nuts, and applications of cylinder oil, it was finally started again.

The main slides had to be dosed with extra oil every half hour. To get at the intermediate I had to go up to the first grating, crawl through and around a lot of pipes and pumps, finally to shove my hand through an opening and squirt the oil. While doing this about two quarts of hot water dropped on my bare neck, causing me to jump so that I nearly fell into the engine.

During one of my attempts to swab the main rods, the brush got mixed up with the crosshead in some unaccountable manner, and away it went clear across the engine room. This called forth another shower of fearful expletives from the third assistant. Next a crosshead key fell out of the feed pump, which consequently stopped, and the natural conclusion was another shower of screaming hot water. I was told to crawl into the bilges and hunt for it. A floor plate was taken up and I squeezed into a heterogeneous collection of crooked copper pipes down underneath the feed pump, where there was plenty of grease and dirty water. The key was finally recovered. In trying to get out, my head came into violent contact with the sharp edge of something, nearly knocking the senses out of me.

About this time the port circulator began to heat at the crank pin. Salt water had to be squirted at it from one of the service pipes on the main engine, immediately followed by a good dose of oil. Pretty quick a piece of packing blew out of a joint on the starboard engine, the steam flying out with a blood-curdling screech. The engineer next sent me out into the fire room for some tool or other.

Arriving there, a new scene was encountered. The air seemed to be full of red-hot slice bars, rakes, hoes, shovels, coal and fine coal dust, ashes, bull niggers, Poles, Spaniards, steam, and water. Doors were yanked open and slammed to; hot fire was falling on to the floor in all directions; and, taken altogether, it reminded me strongly of what the infernal regions are supposed to be like. It so happened that, right at this juncture, a gauge glass suddenly flew into a million pieces with a report like a small cannon, filling the air with hot water, steam, and broken glass. Nidgren, the engineer, came onto the scene just then and let out another long string of unhallowed expressions. The valves were shut in some way or other, a new glass procured and put in.

After being at sea a couple of days, a gale of wind was encountered which blew dead ahead, which made still more excitement down below. A man stood at each throttle to control the runaway engines. As the ship would pitch down and up out of water, both propellers would come, necessitating the quick shutting off of steam, so that the speed would not be so great as to snap the blades off the wheels when they struck the water again. When they raced, I should judge that the engines made about ten million turns a minute. This is very hard on the shafts and is the principal cause of their breakage.

The bilges gave lots of trouble during this rough weather; keeping them clear was nasty work. It was also very hazardous crawling around among the engines, holding on with one hand, feeling and oiling with the other. Taken altogether, there was bedlam let loose—the greatest hullabaloo imaginable.

Out in the fire room things were even worse. Very thick fires were carried, it being necessary often to get on top of the slice bars to crack the raging mass of hot coal. The ship would give a tremendous roll, knocking the poor devils flying against a sharp angle iron or ugly projection. Then another would endeavor to coal up, but most of the fuel went all over the boiler front. The water was pitching up and down—away above the top of the glass, then with a rush away below the bottom: pretty hard to tell just where it was.

When about half way, or a little further, on the passage, we had the misfortune to blow a fusible plug. This happened at 1 o'clock in the morning. The engineer in charge had just left the fire room when one of the firemen screwed the forward check down solid and forgot all about it. In about twenty minutes the plug melted out with a frightful scream. This scared everybody, so that all made a rush for the deck, and not one of them came back until driven down later on. The first assistant somehow was notified and bolted out into the fire hold. It was a pretty mess—a big boiler with four heavy fires, forced draft, low water, and no one in sight! The second assistant shut down the fans, while the first and one oiler started to haul

the forward fires. This was an awful job; as fast as they got out some fire, the hose played on it until the air was chock-full of smoke, steam, coal, and ashes. It was finally done, however; next the forward stop valve was shut, and then the blow-off opened, emptying the boiler in a few minutes. Some planks were placed on the grates, and the chief crawled into the back connections to examine the top of the combustion chamber. This was found not injured; but the hole in the fusible plug had to be filled, and there was no spare plug aboard. A thread was tapped into it and a piece of a bolt screwed in. They hauled out the chief more dead than alive, pumped the boiler up with hot water, and shoveled in the fires again, together with a lot of hot coke from the after boiler. In less than four hours after the plug went, that boiler was working at its full capacity. This is the way they do things at sea.

When the ship arrived at Jamaica we began to be troubled with the most fearful heat. Oh, how unbearable it was down in that seething hot caldron of iron and steel! I had to help pack the main rods, during which operation I expected to faint with the intense strain. I put a bunch of wet waste in my cap to keep my head cool. No ordinary thermometer would register enough to indicate the temperature.

There were also other diabolical jobs to be done; for instance, to pack a pump while lying on your stomach among a lot of dreadfully hot pipes, reaching around in vain attempts to get at it, and hot drops of water hitting you; but it had to be done.

I was glad to get started North again, so as to get out of this paralyzing heat. But there is an end to everything, if you wait long enough, and the time finally came that we arrived home again.

All the foregoing is what one may expect who wants to go to sea in the engine room of an ocean steamer. I have not exaggerated things in the least; in fact, they are not painted black enough. If the men or boys who design the machinery also had to do the work, it would be considerably easier. For instance, have the bilge strainers more easy of access; run the piping a little different, so as to get at auxiliary engines better; arrange a good many of the valves so that it is easier to get at them. Many other little details, if slightly modified, would lighten the labor very much and at the same time be just as cheap.

I have very seldom seen any one employed on a steamship who was glad he was there; he always wished he had a job ashore. It is nothing but hardship, poor food, insufficient sleep, all kinds of vermin, to make life miserable. But there is a most wonderful chance to learn how to run engines and boilers in a practical manner.

Wireless Telegraphy.—The latest reported application of wireless telegraphy for marine protection is that of equipping the seagoing tug *Savage* with DeForest wireless system, by which it is possible for the tug to be in communication with the shore throughout her voyage between Boston and the Chesapeake capes. In case of barges breaking away in a heavy gale, the tug will be able to send a message ashore for assistance.

Experiments on Screw Resistances.

Editor MARINE ENGINEERING:

Allow me, please, a few remarks regarding the interesting experiments with the steamship *Vlaandringen*, described in your magazine by H. Emes Van Gelder.

To get the real thrust delivered on the thrust block a dynamometer was employed, and this showed that owing to the influence of the propeller, the resistance was considerably in excess of the resistance calculated from the tank trials—a result which might be anticipated from the full aft body and the proximity of the screw.

In order to get the part of the I. H. P. absorbed by the ship for propulsion, Mr. Van Gelder multiplies the measured thrust (augmented resistance) in the speed of the ship. This would have been correct if the propeller would have been working in water at rest, but the fact that the screw worked in the wake alters matters considerably; and while the resistance is increased by the disturbance in the wake, on the other hand a saving in power is obtained by reducing the revolutions required for a given speed.

According to Mr. Froude's experiments, the loss due to the resistance augmentation, and the gain by the working of the screw in the wake of the vessel, equal each other, so that thrust H. P. practically equals I. H. P. If the H. P. absorbed by the propulsion of the ship had to be ascertained, the measured thrust (augmented resistance) ought to be multiplied by the speed of ship minus speed of wake, and by so doing we certainly would not get the impossible efficiency of 0.7 for propeller and engines together.

It is interesting to notice that in all experiments carried out with dynamometers, in which the thrust measured was multiplied by the speed of the vessel in order to obtain the work delivered by the screw, excessive high efficiencies were calculated, for the above-mentioned reasons.

A clear example are the French experiments with the *Elorn*, giving 85 per cent., and Isherwood's, with over 80 per cent. If the resistance augmentation of the model of the *Vlaandringen* would have been ascertained by trying it with the screws working behind it, a very interesting comparison could have been made between augmented resistance of model and the augmented resistance of the real ship measured on the thrust block.

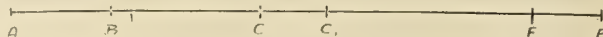
Nowadays models in the tanks are tried with the propellers working behind them, and the position of the screws is fixed up so as to compensate as much as practicable the augmentation in resistance by the gain due to the working in the wake; but it remains still an open question if the position of screw giving the best results for the model is also the best for the ship. This question can only be answered by measuring the augmented resistance with dynamometers on ships and comparing the results with tank trials with and without screws.

A. MELENCOVICH.

The significance of the phrase, "power absorbed by the ship for propulsion," depends somewhat upon the manner in which it is used, and different writers may fairly use the term with different meanings. The simple fact is that there are all sorts of quantities related to the power problem: indicated horse power, power de-

livered to propeller, thrust power, net propeller power, and effective horse power. These various quantities admit of comparison, and all sorts of relations may be developed between them.

These relations may be well illustrated by a diagram as follows:



Let the total I. H. P. be denoted by the length AE . Then the various ways in which the power may be subdivided are represented as follows:

AE = I. H. P. = total power.

AB = power absorbed by friction of engine and attached pumps.

BE = power delivered to propeller.

BC = power absorbed in eddies, rotation, and sternward acceleration communicated to the water acted on, assuming the existence of a wake.

BC_1 = power absorbed under the preceding head, assuming that there is no wake and that the propeller works in undisturbed water.

CE = thrust horse power = product of actual thrust by the speed of the ship relative to the outlying still water.

C_1E = reduced thrust horse power = actual thrust multiplied by the reduced speed of the ship relative to the wake = net propeller power.

FE = power absorbed by the augmentation of resistance.

CF = power absorbed by the true or towed resistance in the case with wake = effective horse power.

The various ratios are also illustrated as follows:

$\frac{CF}{AE}$ = propulsive coefficient.

$\frac{CE}{BE}$ = apparent propeller efficiency.

$\frac{C_1E}{BE}$ = true propeller efficiency.

$\frac{CE}{CF}$ = coefficient of augmentation.

$\frac{CE}{C_1E}$ = wake-return factor.

$\frac{CF}{C_1E}$ = hull efficiency.

Now, the quantities represented in column 12 of table 1 in the article referred to are values of the thrust power, represented by CE in the diagram, and the author seemingly chooses to term this the power utilized as the work of propulsion, and the quotient of this divided by the I. H. P. as the fraction of the total developed power utilized as the work of propulsion. So long as it is perfectly clear what has been done, there need be no confusion; and if the terms employed are not in accord with those which might be preferred, the facts themselves are in nowise affected.

Our correspondent has, presumably by oversight, not expressed his real meaning in stating that, due to the balance of augmentation loss and wake gain, the thrust H. P. practically equals the I. H. P. In the



THE OIL CARRIER CITY OF EVERETT BURNING AT PORT ARTHUR, TEX.

diagram this would call for substantial equality between CE and AE . As will be seen from the analysis above, the hull efficiency is the ratio of CF to C_1E , the effective horse power to the net propeller power, and it is this ratio which the experiments of Mr. Froude showed to be nearly unity. In other words, in so far as wake gain and augmentation tend to balance, so will CF and C_1E tend toward equality. It is, therefore, these two quantities to which our correspondent presumably refers in calling attention to their equality under a balance of wake and augmentation effects.

The value of .70 for CE divided by AE is by no means unusual or extreme. It should not be confused with any of the other ratios mentioned above. These could only be known by a detailed analysis which would give for the ship both the augmentation and wake effects. These were not in hand, and the author therefore gives simply the discussion of such results as came directly from the observations made.

We are quite in accord with our correspondent in urging further measures of actual resistance on full-sized ships for comparison with tank trials, with and without screws, in order to throw further light on this important question.

Lloyd's Register Shipbuilding Returns.—From the returns compiled by Lloyd's Register of Shipping for the quarter ended September 30, 1903, it appears that, excluding warships, there were 393 vessels, of 906,608 gross tons, under construction in the United Kingdom. This shows a decrease in the tonnage under construction of about 122,000 tons as compared with the figures for last quarter, and a decrease of about 507,000 tons as compared with the total reached in September, 1901, which is the highest on record. The tonnage for the quarter ended September 30, 1903, is divided as follows: 353 steel steam vessels, of 889,035 gross tons; one steam composite vessel of 220 gross tons. The sailing tonnage consisted of 39 vessels, of 17,353 gross tons, 12 per cent. of the tonnage being of steel. Of the total tonnage for this quarter, 310 vessels, of 743,650 gross tons, were built for parties in the United Kingdom. The battleship construction for this period at private and government yards was 64 vessels, of 327,570 tons displacement.

Tank Ship Burns.

On the night of September 7 the oil-tank steamer *City of Everett*, of the Standard Oil Company, took fire while receiving a cargo of oil at Port Arthur, Tex. The vessel was lying at the Texas company's oil wharf No. 3, and had just about received her full load of 1,200,000 gallons. It is asserted that fire was caused by an explosion of gas in one of the holds, the gas being ignited by a spark caused by defective insulation of a portable electric light. The second officer of the ship was holding the light in a hatch to note the progress of loading. When the explosion took place the ship was at once enveloped in smoke and flames, and the crew had to take to the water. There were no facilities for fighting the fire, for the only stream of water that could be brought to bear on the burning ship was from a tugboat, which proved most inadequate. On the following day a fire engine was placed on a barge and towed near the burning ship, and the day afterward an additional hose was secured from another ship in port, and the fire was finally gotten under control, but not, however, until most of the oil had burned and the vessel badly damaged.

Booms were slung across the bayou to prevent the burning oil, which was floating on the water, from spreading to the shipping and docks near by. The dock to which the vessel was moored was completely destroyed.

The *City of Everett* was built in 1895, at Everett, Wash., for the Standard Oil Company, and is of the whaleback type, 348 feet long, 42 feet beam, and 26 feet 7 inches deep, with a gross tonnage of 2,504 tons.

French Warships.—The French naval programme for 1904 calls for the construction of 70 vessels, including 50 torpedo boats, 16 submarines, 1 armored cruiser, and 3 torpedo-boat destroyers.

Seagoing Torpedo-boat Destroyers.—The first of the 25 1-2-knot seagoing, English torpedo-boat destroyers, building by the Palmer Shipbuilding Company, Yarrow, England, have been launched and are now undergoing preliminary trials. These vessels are 225 feet long, 23 feet 6 inches beam, and have engines of 7,000 I. H. P. These boats are somewhat heavier throughout than the former type, yet, because of the contract trial conditions, the decrease in speed is not as much as apparent.

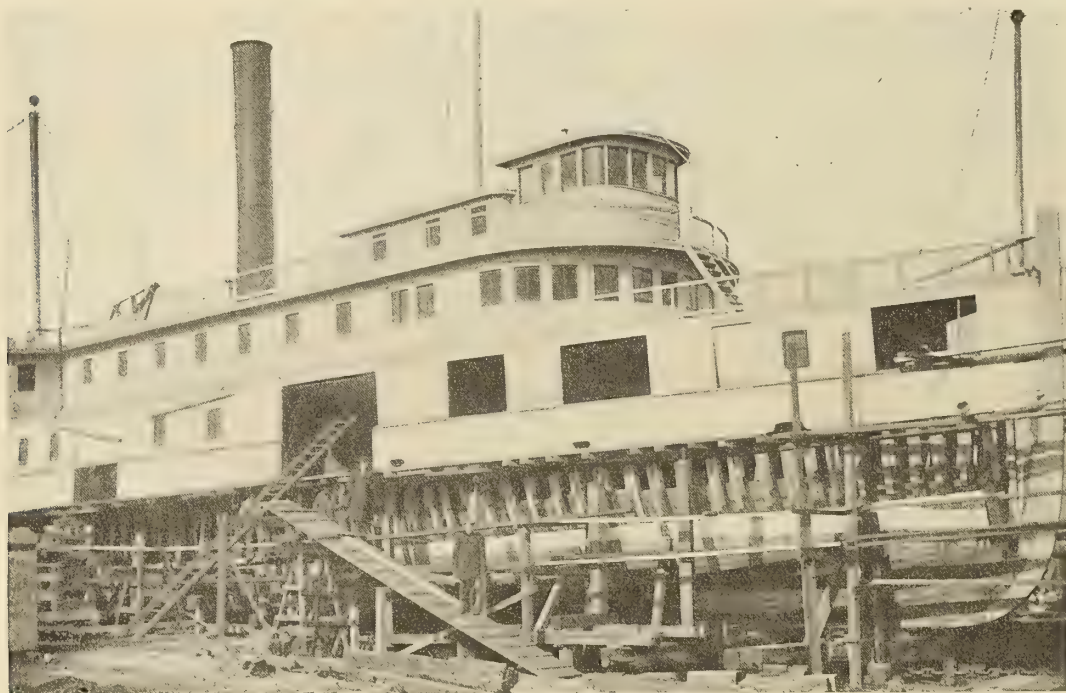
An Interesting Naval Operation.

Editor MARINE ENGINEERING:

Lengthening a ship is now quite an ordinary feat in ship-repair work, although nevertheless the operation is a difficult one. When a ship does not trim as she should, or, more especially, when it has been decided to increase her carrying capacity, the vessel is placed in dry-dock, cut in two in the middle, and one end drawn from the other; the intervening space being built up with frames and plates the same as the rest of the structure of the vessel. The steamer *Indian*, of the Boston and Philadelphia Steamship Line, was successfully lengthened 40 feet at the yard of Harlan and Hollingsworth Company, Wilmington, Del. The ship was originally 227 feet long, 38 feet beam, with a gross

support the overhang. The remaining twenty-five were placed inside the hull of the boat, in a double row amidships, port and starboard of the boilers and engines, and in a single row fore and aft. The screws used were the regular lifting or jack screws, with holes in the top in which a bar could be inserted to make the necessary turns.

The manner of holding up the ship was as follows: In the hold were three built-up piles of good, strong wood with the blocks laid crosswise; on the outside, under the guards, were nine piles similarly constructed. These supports are called cribbings, and are placed at regular intervals; the part they play in the operation being that of steadying the deck structure. Twelve of the screws were placed on these cribbings. In



STEAMBOAT ULSTER, INCREASED IN DEPTH.

tonnage of 1,576 tons. The illustration was taken directly after the boat had been severed and drawn apart from the rest of the hull.

It remained, however, for the Saugerties and New York Steamboat Company to undertake a new departure in increasing the efficiency of one of their boats, the *Ulster*. This vessel is 205 feet long by 30 feet beam, and of 690 gross tons. She is propelled by a walking-beam engine with a cylinder 42 inches diameter by 9 feet stroke. Her speed was not up to the standard of the rest of the fleet, and, when heavily loaded, her free-board was entirely too small. To overcome this serious difficulty it was determined to increase the depth of the boat by adding on two feet. This was done by cutting the upper part of the ship, just above the guard, entirely away from the lower part. This took place while the vessel was in one of the dry-docks at Erie Basin, South Brooklyn, N. Y. After this had been carefully done, seventy-three screws were distributed at as many different points; forty-eight were placed in the outside, in a double row, under the guards, to carry up and

between these solid square cribbings were placed the other sixty-one screws, set in upright posts hollowed out at the top, called "pumps." They were so arranged as to carry practically as much of the weight as the other screws. From practice, as well as theory, the lifting power of each had been determined upon as five tons.

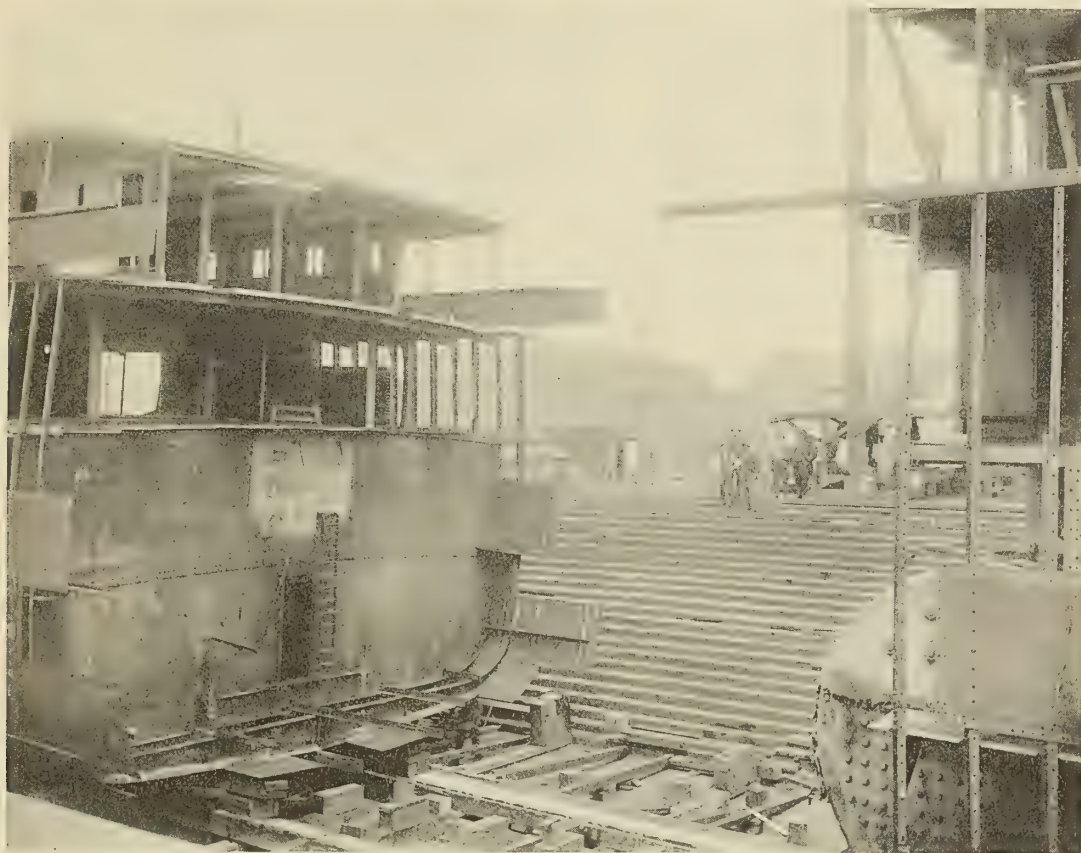
The upper part of the ship was lifted away from the lower part in this fashion: Workmen were placed at every third screw; when the signal to start was given, the men, moving and working as nearly automatically as possible, passed from screw to screw, giving each one, as they passed it, a quarter of a turn. This lifted the boat up about one-fifth of an inch; this was kept up until the limit to which the screws could be raised was reached, when there was a space of about six or eight inches between the ship and the cribbings. Two blocks, laid crosswise, were placed in this space. By driving wedges between these blocks the ship was raised several inches. This was necessary in order to admit of taking out the screws, putting new blocking under

them, and so raise them up. When the "pumps" were removed, shores were used temporarily until longer "pumps," into which the screws were fixed, could replace them. In case longer "pumps" were not at hand, blocks were placed under the original ones. The jacking-up process was again started, the men working as before. This operation had to be continued until the desired space—24 inches—was obtained.

The operation was in every way a decided success. There were no joints sprung, nor were the decks strained in the least. After the desired depth had been obtained, every frame was spliced where it had been cut. The stem and stern were also spliced. The gap made

John Calder has resigned the position of executive engineer with the C. W. Hunt Company, New York, to become general manager of the Remington typewriter factories at Ilion, N. Y.

Rear-Admiral Francis T. Bowles, Chief Constructor of the Navy, has resigned his position to accept the presidency of the Fore River Ship and Engine Company. Mr. Bowles has been Chief Constructor of the Navy for the last two years and when appointed was the youngest of the rear-admirals. The former president, Thomas A. Watson, has become chairman of the board of directors. There are three United States battleships, the *Rhode Island*, *New Jersey*, and *Vermont*,



STEAMER INDIAN, CUT IN HALF FOR LENGTHENING.

in the hull was then covered over, and, after several coats of paint had been applied, the vessel was again ready for service.

Her speed was considerably increased, due to the fact that the wheels were not submerged as deeply as before, and her greater freeboard gave an increased carrying capacity. Thus was demonstrated practically the success of this curious and enterprising operation.

JOSEPH C. WILSON.

PERSONALS.

Richard L. Newman, late of the Globe Iron Works and the New York Shipbuilding Company, wishes to state that the dummy president of the United States Shipbuilding Company, reported in the papers to be a Mr. Newman, is not to be confused with Mr. R. L. Newman.

and the protected cruiser *Des Moines*, building at this yard.

Washington L. Capps has been appointed Chief Constructor of the Navy to fill the vacancy created by the resignation of Mr. Francis T. Bowles. Mr. Capps has been constructor in charge at the New York navy yard.

Eads Johnson, formerly the New York agent for B. B. Crowninshield, is superintending constructor to the Lighthouse Department at Staten Island, New York.

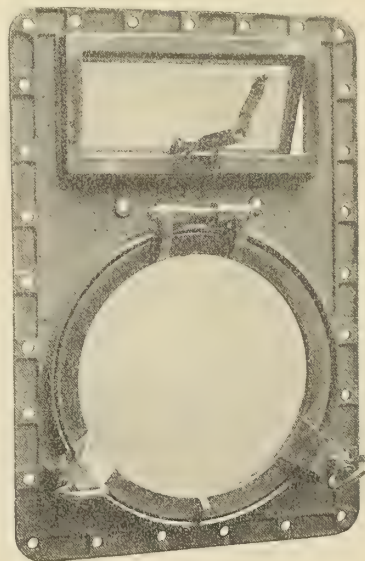
Charles A. Wheeler, formerly inspector of steel for Revenue Cutter Service, Pittsburg, Pa., is now assistant engineer on the U. S. S. *Algonquin*, New London, Conn.

J. Cameron has lately left the Moran Brothers and gone to the hull drafting room of the Union Iron Works to take charge of the sugar steam schooner *Likeline*, building for the Wilder's Steamship Company, Ltd.

ENGINEERING SPECIALTIES.

Large-Sized Air Ports.

The cuts below show the inside and outside views of a side light furnished for the steamships *Mongolia* and *Manchuria*, the 615-foot vessels now being completed at the yard of the New York Shipbuilding Company, Camden, N. J., for the Pacific Mail Steamship Com-



INSIDE AND OUTSIDE VIEWS OF LARGE SIDE LIGHT.

pany, New York. These lights, 102 of which will be installed in each of the above vessels, are of a very excellent type, both in regard to appearance and construction.

The upper portion, the glass of which is chipped to a neat design, acts as a ventilator, and has for this purpose a screw gear. The lower light is a 15-inch, hinged light, with a clear opening of 16 7/16 inches.

These lights are constructed for heavy sea service, and at the same time are made as light as is consistent with strength from the point of economy, all unnecessary material being cored out. The material used is yellow brass, and all the parts visible from the inside are highly polished.

The contract for these lights, together with 92 hinged square lights intended for the same vessels and 22 fifteen-inch hinged round lights, comprising in all 318 lights, with an aggregate weight of 33,240 pounds and being composed of 18,415 distinct pieces, was given to the Delaware Marine Supply Manufacturing Company, of Wilmington, Del., who made the metal patterns and furnished the lights complete.

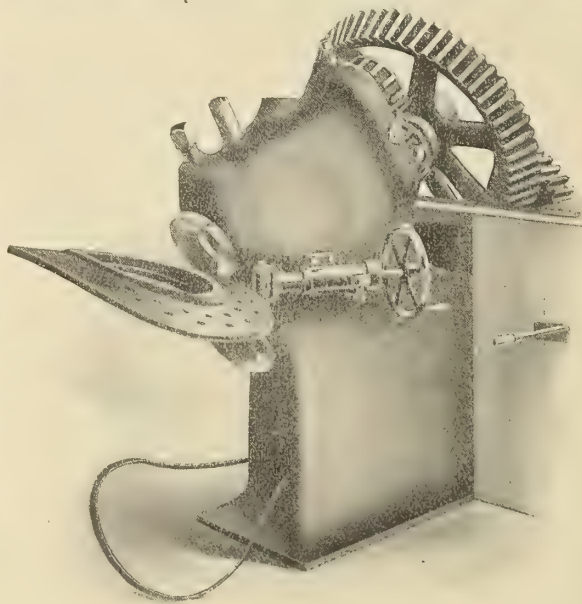
Radial Bevel Shear.

The Lenox rotary bevel shear here illustrated presents many novel features, performing such work as has heretofore taken a great amount of hand labor, or else, if the bevel is to be well finished, has required placing of the piece on a planer, thereby making the work expensive in time and labor. The Lenox machine is made for cutting steel of any thickness from 1-8 to

3-4 of an inch, on a bevel. The work is done by rotary blades which revolve in opposite directions, beveling and feeding the plate while they cut it. The machine is built in two sizes; for cutting plates up to 1-4 inch requires 3 horse power, and the larger size, for cutting up to 3-4 inch, requires 8 horse power.

The shear works equally well on straight or curved sheets, and, as is shown in the cut, can be used for beveling such unhandy and irregular shapes as a man-

hole saddle, and gives a clean, even finish. Other special uses for this machine are for beveling furnace



ROTARY BEVEL SHEAR.

flanges on boiler headers, straight and curved edges of a boiler dome sheet, beveling angles, etc.

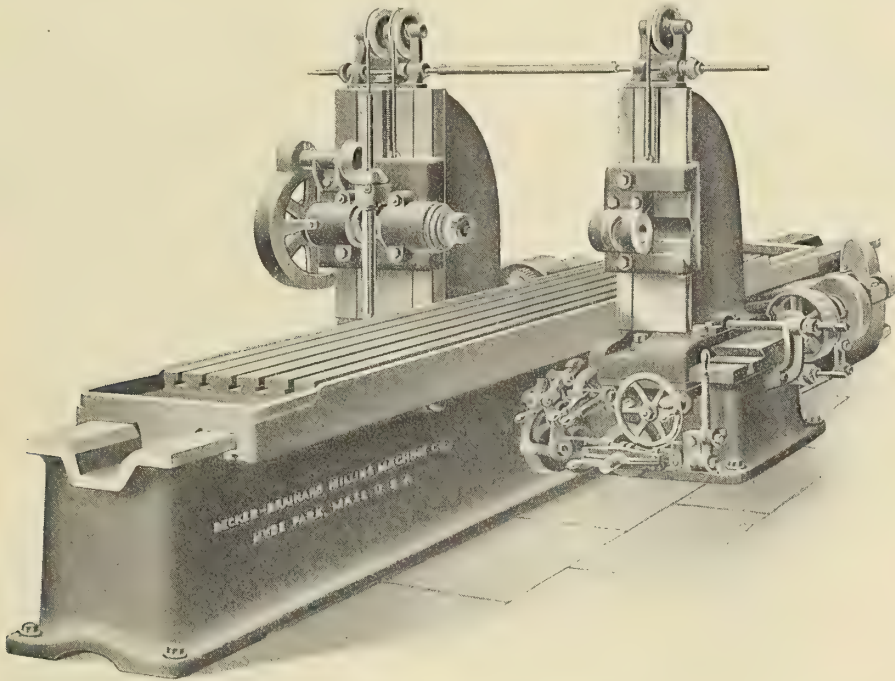
The plates are made from high-grade tool steel and

carefully turned and milled, thus making them self-feeding; the upper plate is double-edged, so in case of damage to one cutting edge it may be quickly reversed and the opposite edge used. The plates will not receive a plate that is too thick, nor admit of a prying-off strand.

A special type of machine, called a splitting shear, built on the same principle, is capable of working four or five hundred feet of plate in an hour, the speed being limited to the ability of the operator. The shear is sold by Joseph T. Ryerson and Company, Chicago.

ratios of 13 to 2 and 27 to 1 by 5-inch belt on a 5-step cone, the diameter of which is 23 inches on the largest step and 13 inches on the smallest, giving a range of feed through eight changes from 3-64 to 3-8 inches. These changes of feed can be made instantly by means of a lever without stopping the machine.

The head may be adjusted in either from either side of the machine, so that it is not necessary to take the cutters off the arbor in order to change their position in relation to the work. The bed is extra deep, extending to the floor and making a solid foundation. It is



A NEW PLANER-TYPE MILLING MACHINE.

Planer-Type Milling Machine.

The Becker-Brainard Milling Machine Company, Hyde Park, Mass., has recently gotten up new designs for a 32 by 36-inch by 10-foot planer-type milling machine of very heavy construction and power, while, at the same time, special provisions are made for operating the machine with ease and to meet the demands of modern practice. The spindle is of hammered crucible steel, 5 inches in diameter; has a threaded nose, and runs in self-centered bronze boxes, with nut and check nut to compensate for wear. The spindle carrier is very heavy and is held firmly to the upright by long gibs. It is elevated by a screw with adjustable dials graduated to thousandths of an inch, and has a counterbalance for ease of operation. There are 20 changes of speed for the cutter spindle obtained by gearing in the main driving cone, operated by clutch and lever, so that all changes can be made instantly.

The table is very heavy and is regularly built, with five T-slots lengthwise and an oil channel the full length and at each end. It travels on flat ways securely gibbed, and has a quick return operated by power from a separate countershaft. It can also be moved by the usual hand wheel. The feed of the table is directly operated through gearing from the spindle at

securely braced by heavy cross-girders which are evenly spaced throughout the entire length. The bed can be made any length desired. The specifications provide for a machine with the greatest capacity, and the net weight of it is 25,000 pounds.

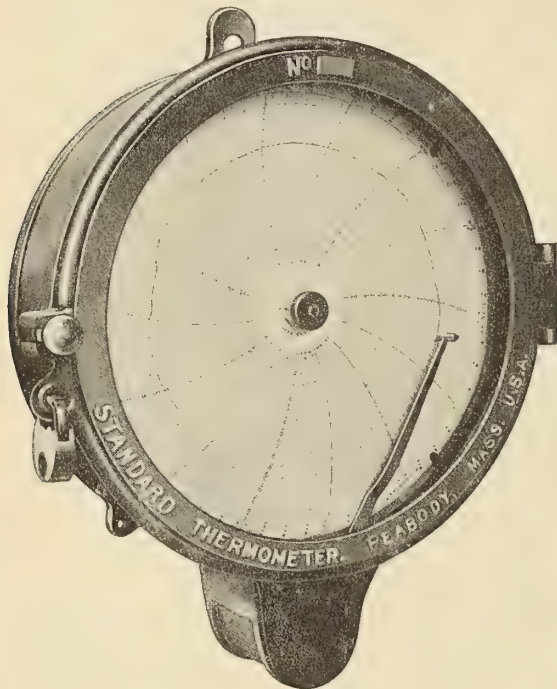
Recording Thermometer.

The use of the thermometer in engineering is daily assuming a more permanent place. As an indicator of temperature conditions it is the greatest service to the engineer. Following closely the simple thermometer, the recording thermometer has been extensively introduced for cold-storage compartments, besides for use in recording the temperatures of the air of engine room or cabin. Here is given an indisputable testimony of temperature.

In the form of a thermometer, here illustrated, advantage is taken of the well-known principle of differential expansion by heat in a metallic strip made of two or more metals and the consequent distortion of the strip or lamina. In the recording thermometer the bi-metallic strip or lamina is in the form of a helix; one end is fast and the other end carries the pen over the recording sheet. The recording sheet is ruled into 120 spaces and is carried by a high quality eight-day

escapement clock. The zero of the dial can be at any point on or off the scale, and the thermometer can be made to record temperatures up to the point where the heat would stop the clock, between 250 and 300 degrees Fahrenheit. The lamina can be adjusted to either the Fahrenheit, Centigrade, or Réaumur scale.

The general appearance of the instrument is workmanlike and neat; the round case covers the clock and dial; the glass front opens on a hinge shown at the right of the cut and is latched by the thumbscrew shown at the left. It can be locked by passing the staple of a



STANDARD RECORDING THERMOMETER.

padlock through the eyes below the thumbscrew. The clock movement is rigidly attached to the back of the instrument, and the construction of the case is such that dust is prevented access to it.

The protuberance below the case in the cut shows the lamina cover; this is perforated in order to get as great sensitiveness of operation as possible—it is so sensitive that it records a breath. There are eyes for screwing or fastening it to a wall. The pen is made of a hard nickel alloy, and is readily set, if it gets out of position, by means of a setting screw at the lamina holder.

These thermometers are made by the Helios-Upton Company, Peabody, Mass.

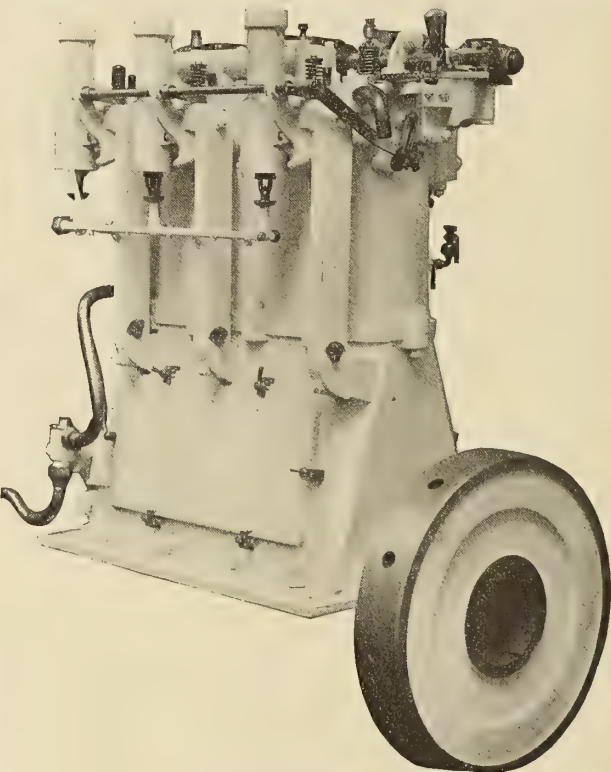
Bertheau Reversible Oil Engines.

The most important novelty about the Bertheau oil engine, and that which specially recommends it for marine purposes, is that it is reversible; that is to say, the engine itself runs either way, and so can be connected rigidly to a screw propeller or other shafting without the complication of reversing clutches. This is effected by means of a double set of cams, which can be shifted by simply moving a reversing lever, as in

the case of a steam engine. The engine has three cylinders, so that there are no dead points, and it can therefore be started, stopped, and reversed instantaneously.

These engines are also fitted with a reservoir containing burnt gases at a pressure of about 100 pounds per square inch, for purposes of starting and maneuvering, and these are filled with burnt gases from the cylinder; the gases being admitted by means of a relief valve arranged to open at a pressure slightly below that of explosion. The reservoir is replenished by letting burnt gases enter for a few revolutions after starting, and then is shut off.

The oil used in these engines is heavy petroleum; that is to say, it has a specific gravity from .82 up-



THREE-CYLINDER REVERSIBLE OIL ENGINE.

ward, with a flash point of 86 degrees Fahrenheit and above. The consumption of oil is about 1 pound per brake horse power per hour.

The engines are made in the following stock sizes:

B H P.	Revolutions per Minute.	Weight, including Automatic Starting Reservoir.
4	600 (about)	4 cwt
10	500	11 1-2 "
15	325	25 "
30	275	40 "

The weights given (which include reservoirs) are subject to slight modification, as they are somewhat dependent on the convenient disposition of the reservoirs. The 4 brake horse power has only one reservoir. The engine is made by John I. Thornycroft and Company, Limited, Chiswick, London, England.

Lippincott Specialties.

The annexed engravings represent a line of Lippincott's patented indicators, reducing wheels, and planimeters. Fig. 1 is a section view of the engine indicator and is almost self-explanatory. The radical difference between this instrument and others consisting more particularly of the frictionless piston and swivel elbow, the

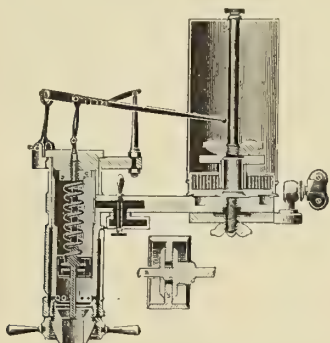


FIG. 1.—SECTION OF PATENT INDICATOR WITH FRICTIONLESS PISTON.

latter for discharging the exhaust steam away from the operator, no matter what his position. The frictionless piston has reduced the friction to almost nothing, and consists of a piston rod elongated sufficiently to pass through the spider at the bottom of the cylinder, to form a bearing at the bottom as well as on the top. The piston web is carried between the steel flanges in such a manner as to permit a slight lateral movement,

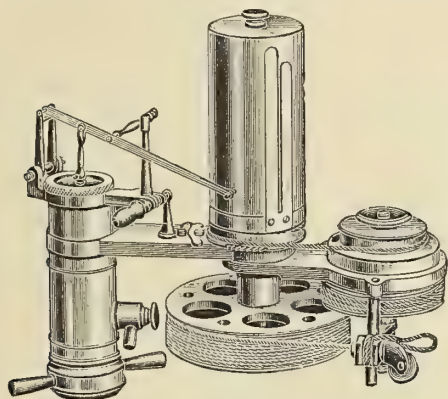


FIG. 2.—INDICATOR WITH REDUCING WHEEL ATTACHED.

so that no matter how much the piston rod may be bent, no pressure can exist between the piston and the cylinder, and, therefore, no friction.

Fig. 2 shows the Lippincott "Peerless" reducing wheel, patented, attached to an indicator, and this wheel is so constructed as to permit of attachment to any make of indicator, and will operate successfully at any speed up to 500 and on any stroke up to six feet, and is made in a larger size for strokes up to eight feet.

The Improved Lippincott planimeter, Fig. 3, is provided with two triangular scales, each having six graduations, or twelve in all, the instrument being capable of giving a reading from the pointer over the scales, the mean effective pressure of any indicator diagram without computation, or by setting according to instruc-

tions, a reading may be had in square inches and tenths. These instruments are made by the Scranton Steam Pump Company, Albright avenue, Scranton, Pa., from whom full particulars may be obtained.

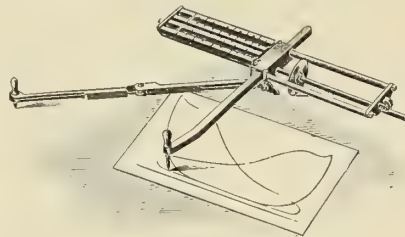


FIG. 3.—PATENT PLANIMETER

LAUNCHES.

Austrian Battleship Archduke Karl.—On October 4 there was launched from the works of the Stabilimento Tecnico, Trieste, the first-class battleship *Archduke Karl*. The hull and machinery were the design of the builders. The ship is of a new type and will be the largest battleship in the Austrian service. Her dimensions are as follows: length between perpendiculars, 390 feet; breadth, extreme, 71 feet 6 inches; draft, mean, with all weights on board, 24 feet 6 inches; displacement with all weights on board, 10,600 tons. The vessel is fitted with two masts with the usual signal yards, the foremast being also fitted with military top. Practically all the material used in the construction has been supplied by Austrian and Hungarian steel makers; while the armor, of which there is close on 3,000 tons, is being supplied by Witkowitz, and is of nickel chrome steel treated by the cementation process. The hull is constructed of Siemens-Martin steel, and the design is generally in accordance with the most modern practice for vessels of this type, the subdivision of the vessel into water-tight compartments being such as to assure sufficient buoyancy and stability under all probable conditions of damage; the double bottom, which extends for a length of 255 feet, being minutely subdivided. Deep bilge rolling keels are fitted on either side for about half the vessel's length amidships. The armor belt, which is 8 feet 9 inches deep by 8 1-4 inches thick, extends for a length of over 250 feet amidships, the lower edge being 4 feet 9 inches under water when the vessel is in sea-going condition; above this belt the broadside is protected to the height of the battery deck by armor 4 3-4 inches in thickness; while above this again on the battery deck a citadel encloses 8 of the 19-cm. guns of the secondary battery. An armored protective deck, 3 1-4 inches thick on the sides, is fitted all fore and aft.

The gun equipment consists of four 24-cm. quick-firing guns mounted in pairs in barbettes, one barrette being aft and one forward the barrette armor being 9 1-2 inches thick. These guns, which have a length of 40 calibers, are supplied, as are those of the secondary battery, by the firm of Skodawerke, Pilsen. The forward guns have an arc of training from right ahead to 40 degrees abaft the beam. The muzzle energy of these guns with a 470-pound shot is equal to 6,170 metric tons, capable of penetrating about 16 inches of

nickel chrome steel, the range at the maximum degree being 10 miles. The training, elevating, loading, and otherwise working of the guns is done by electricity. The secondary battery is composed of twelve 19-cm. quick-firing guns, eight of which are mounted in separate casemates in the before-mentioned citadel on the battery deck, four on each side; while the other four are arranged on the upper deck, two on each side. Four aimed shots per minute can be fired from these 19-cm. guns, the shot being 198 pounds in weight and the muzzle energy 3,315 metric tons, equal to a penetration of 9 inches of hardened-steel armor. Fourteen 7-cm. quick-firing and sixteen machine guns, variously distributed, complete the gun equipment. In addition to the above, the vessel is fitted with two under-water broadside torpedo tubes for 18-inch Whitehead torpedoes. The vessel will be commanded, when in action, from two armored conning towers; these, as is usual, being fitted with the necessary armored communication tubes carried down to the protective deck.

The electric-lighting outfit consists of two steam-driven dynamos, each of 50-Kw. capacity. The lamps necessary for the efficient lighting of the ship are upward of 700 in number, while in addition to these there are seven searchlight projectors, each of 25,000-candle power. The turrets and guns of the 24 and 19-cm. guns are operated by electricity, current being supplied by seven dynamos, so connected that any dynamo may also be used for lighting purposes if necessary. The boats, of which there are fourteen, are swung from two large davit cranes.

The vessel, which is of the twin-screw type, is propelled by means of two four-bladed bronze propellers driven by independent sets of 4-cylinder, vertical-inverted, triple-expansion engines capable of developing 14,000 indicated horse power at 132 revolutions and of giving the vessel a speed of 19 1-4 knots per hour. At an economical speed the vessel will have a radius of action of 4,500 miles, the bunkers having a capacity of 1,315 tons. The cylinders are of the following dimensions: 30, 51, 60, and 60 inches diameter by 39 inches stroke. There are twelve Yarrow boilers for supplying steam to the main and auxiliary engines, the working pressure being 300 pounds. The Howden system of forced draft is used, and there are three boiler rooms with four boilers in each. A distilling apparatus is fitted which is capable of supplying 120 tons of fresh water in twenty-four hours. A very complete installation of auxiliary machinery for all purposes is fitted, there being not less than 87 independent auxiliary machines, with 146 steam cylinders, for the various requirements.

Oil-Tank Barge No. 27.—On September 23 the Standard Oil Company's oil-tank barge No 27 was launched from the Townsend-Downey Shipbuilding Company's yard at Shooter's Island, New York. The barge is 355 feet over all and is provided with 20 oil tanks, varying from 12 to 28 feet long and 33 feet deep, and will be able to carry 1,800,000 gallons of oil. The barge will have five steel masts, one of which will be used as a smokestack. Her sister ship, known as No. 28, is building on adjoining ways.

Steamer Hedwig Menzell.—On September 5 there was launched from the yard of the Flensburg Shipbuilding Company, Flensburg, Germany, the steamer *Hedwig Menzell*, built for the Chinesische Küstenfahrt Gesellschaft. Her principal dimensions are: length over all, 244 feet; breadth, extreme, 35 feet 2 inches; depth, molded, 18 feet 3 inches. She will have triple-expansion engines with cylinders 15, 23 1-2, 43 1-4, and 34 1-2 inches stroke. Steam will be supplied by two boilers 11 feet 2 inches by 9 feet 10 inches in diameter. The carrying capacity of the *Menzell* will be 2,050 tons.

Steamship Missouri.—On August 20 the Atlantic Transport liner *Missouri* was successfully launched at the works of the Maryland Steel Company, Sparrow's Point, Md. The *Missouri* would have been launched last year had not her construction been delayed by fire in October, 1902. Her principal dimensions are: length over all, 505 feet; length between perpendiculars, 490 feet; beam, 58 feet; depth of hold, 43 feet; displacement, load, 17,200 tons; net register, 5,131 tons. Twin screws are driven by triple-expansion engines with cylinders 25, 42 1-2, and 72 inches diameter with stroke of 48 inches, which propel the vessel at a speed of 12 knots. Steam is supplied from two double-end and two single-end Scotch boilers fitted with Howden's system of forced draft. This ship was fully described in MARINE ENGINEERING of January, 1903; she will cost complete about \$730,000.

Lighthouse Tender Magnolia.—There was recently launched from the Baltimore Dry-Dock Company's yard the lighthouse tender *Magnolia*, especially designed for service on the Gulf. This service requires both a vessel capable of going to sea and also to navigate the shallow waters of some of the Gulf ports. She is fitted with two tanks which when filled with water will give a maximum draft of 9 feet, while when emptied the tender draws but 6 feet 6 inches. The hull is of steel, 173 feet 2 inches long, 30 feet 3 inches beam, and 13 feet 1 inch depth molded, and displaces, at 9 feet draft, 550 tons. She is propelled by twin screws driven by compound engines with cylinders 18 and 34 inches by 24 inches stroke. Two Scotch boilers will supply steam at a working pressure of 120 pounds. The vessel is schooner-rigged and thoroughly equipped for handling buoys and carrying supplies to the lighthouses.

Car Ferry Père Marquette 19.—Another large ferry-boat for the Père Marquette Railway Company was launched on October 17 from the Cleveland yard of the American Shipbuilding Company and christened the *Père Marquette 19*. The new steamer has no passenger accommodations, but in other respects is a duplicate of *Père Marquette 17*, turned out from the same yard. She is 350 feet over all, 338 feet keel, 56 feet beam, and 36 feet deep. She is driven by two sets of triple-expansion engines with cylinders 19, 31, and 52 inches by 35 inches stroke. Steam is furnished by four Scotch boilers 13 feet 9 inches diameter by 12 feet long. She will be operated between Ludington, Manitowoc, and Milwaukee on Lake Michigan, and will carry 30 loaded cars at a speed of 15 miles. The cars are run on board the main deck at the after end. The new boat will cost about \$400,000. A sister ship, to be named *Père Marquette 20*, is building at the same yard, and after launching will be towed to Chicago for fitting out.

QUERIES AND ANSWERS.

Q. 165.—Please advise me how to calculate the necessary horse power of a centrifugal pump dredge, especially like that described in the June number of MARINE ENGINEERING. Also, please advise how to find the equivalent total head pumped against.

A.—In order to calculate the horse power in a dredge pump it is necessary to have the following items:

1. Quantity and kind of material to be dredged.
2. The length of pipe through which this material is to be carried.
3. The diameter of the discharge pipe.
4. The velocity of the flow of liquid, which depends upon the weight of the material to be carried through the pipe.

The quantity of material in cubic feet discharged per minute, multiplied by the weight of said material per cubic foot, times the total head, divided by 33,000, gives the horse power. The horse power multiplied by the efficiency would give the I. H. P., and to this about 15 or 30 per cent. should be added for the maximum power.

The equivalent total head pumped against is obtained more from special conditions of each individual problem than from formulas, and is governed by the following conditions:

(a) The frictional head per total length of pipe, which depends upon the size, thickness, and arrangement of the pipe.

(b) The velocity.

(c) The suction head.

(d) The elevation to which the material is lifted.

Considering the discharge as a fluid, the friction and velocity heads may be found by referring to formulas in hydraulics.

Q. 175.—I have a 40 by 5-foot speed launch with two 10-horse-power, double-cylinder, four-cycle gasoline engines with right and left propellers. Kindly inform me which would be the proper way to have the propellers turn—that is, what I mean, either to have them turn out or in. H. C. D.

A.—The more common arrangement is for the shafts to turn outboard; that is, for the starboard propeller to turn right-hand and the port propeller left-hand, when standing at the stern and looking forward. The inverse arrangement has been tried with no apparent effect on the propulsive efficiency, so that if you have any particular reason for preferring one rather than the other, so far as your engines are concerned, it would probably make no difference and you might choose in accordance with such reasons. If, however, no such special reasons exist you would find it more in accord with the usual practice to fit them to turn outboard, as noted above.

Q. 176.—Please decide the following: At a recent examination the following question was asked:

If your pump was in perfect condition, and after having run for some time you saw it was not feeding the boiler, what would be the cause?

Applicant claimed, if in perfect condition, it would feed the boiler or stop—if the joints, etc., held out.

Examiner claimed the check would be fast on the seat and the pump keep running.

Conditions: Water above suction side of pump; steam from boiler direct to pump, 100 pressure per square inch, feeding against same pressure. Steam pipe, etc., as called for. Pump 6 by 4 by 8, double-acting, check valve hinge. Stop valve be-

tween it and boiler. Everything clear to boiler shut down three hours.

T. R.

A.—This is largely a matter of the definition of terms and as to what is meant by perfect condition. A pump might be in perfect condition throughout and might be run without delivering any water, simply because it was getting none to deliver. Suppose the suction were dry or clogged, or shut by a valve; then while the pump would run it would feed no water. In any such case, however, it would be instantly clear to any one in the least familiar with pumping machinery that the pump was not handling water. The operation of a pump when pulling against a closed suction and when handling water under normal conditions is so different that no one accustomed to such matters would be long in doubt as to the condition in question. In the case supposed, it is stated that the water on the suction side is above the pump. If, then, the suction is open and the pump is in perfect condition and is operating, it will mean that it is handling water and that, in consequence, the water is going into the delivery pipe. If it is going in it must be going out, and either through the check valve into the boiler or elsewhere. Thus there might be a branch pipe leading from the feed pipe with valve partly open; or, again, there might be a split in the pipe and the water might be leaking into the bilge. If the check valve is closed and no other way of escape exists for the water, the pump will obviously either stop or burst the pipe or connections on the delivery side. It is readily seen from the above brief discussion that it is very necessary to exactly specify all the possible conditions which may affect the problem, and the answer is then usually simple and beyond question. Without such exact specification various probabilities may exist, and there may be abundant room for various differences of opinion.

In the present case it seems to be assumed that the pump is handling water, and if so it is not clear how it could continue running with check valve fast on seat, unless there was some other way of delivery or escape, such as a branch pipe or leak, as noted above.

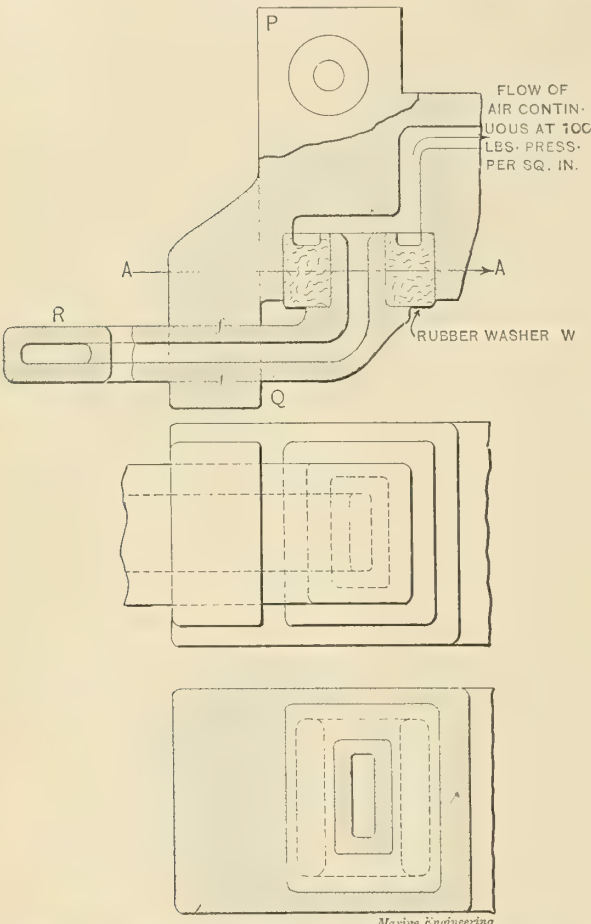
Q. 177.—I wish to use a special form of rubber washer, as illustrated below, but do not know whether it will stand the service to which it is to be subjected. The ranges of temperature will be from 32 degrees to 100 degrees Fahrenheit. It is used as a cushion between *P* and *R*. *P* is a rigid piece of metal, with guide, *Q*, through which passes metal *R*, which vibrates backward and forward with relation to *P* in direction *AA* at rate of 2,000 per minute.

Through *R* is an air passage, and *W* is a rubber washer, which is supposed to take up the vibration of *R* so that it will not be communicated to *P*. The weight of *R* also falls upon *P*, or, that is, upon the rubber, and thence upon *P*, and is perhaps 15 to 20 pounds.

A. J. C.

A.—The surest way of settling a question of this character is, of course, to try the experiment. So far, however, as experience indicates, good rubber should stand the range of temperature which you specify, with but slow deterioration and loss of elastic properties. All vulcanized rubber, under atmospheric influence, gradually stiffens, becomes brittle, and loses its elasticity. This will, of course, take place in time, with such use as you wish to put the washer to. If, however, the air flowing through the tube is dry and free from oil, as well as the general surroundings of the washer, it

may be fairly expected that the washer will render good service under a temperature not exceeding 100 degrees F., and that it will only require renewal at relatively long intervals. In other words, there would appear no reason why a rubber washer, protected from moisture and



especially from oil, should not render all the service which might be fairly expected from such a device, so long as the temperature does not materially exceed the limits specified.

Q. 178.—Will you please advise me which are the ten leading ports of the world, giving the approximate tonnage of shipping of each port? Also, is Liverpool as progressive as the other great ports?

A.—Through the courtesy of the Bureau of Statistics, Department of Commerce and Labor, we present the following table, which shows the relative rank in tonnage movement of vessels at the principal ports of the world. Owing to the fact that the coastwise tonnage for the port of New York is not available, the figures of tonnage in the table are for foreign commerce alone.

	Year.	Entered.	Cleared.
London	1902	10,179,023	7,385,085
New York	"	8,982,767	8,415,291
Antwerp	"	8,373,528	8,347,483
Hamburg	"	7,860,323	7,993,166
Hongkong (a)	1901	7,383,683	7,340,586
Liverpool	1902	6,843,200	6,314,514
Cardiff	"	4,688,088	7,868,556
Kotterdam	"	5,950,445	5,733,763
Singapore (b)	1901	5,459,032	5,453,999

	Year.	Entered.	Cleared.
Marseilles	1902	4,911,784	4,552,088
Tyne Ports	"	3,615,046	4,754,301
Gibraltar	1901	4,171,350	4,159,272

(a) Exclusive of Chinese junks engaged in the foreign trade. The tonnage of these vessels entered and cleared was 1,126,931 and 1,130,279, respectively, in 1901.

(b) Exclusive of warships, transports, native craft, and vessels under 50 tons, but inclusive of vessels engaged in trade between the settlements.

Concerning the progressiveness of Liverpool, we would suggest that you write to the U. S. consul stationed there. Large improvements have been made in the docking facilities of that port.

Q. 179.—Will you kindly advise me, through the Queries and Answers column of your MARINE ENGINEERING, dimensions and horse power complete of a trunk-cabin, cruising gasoline launch, 40 feet long, and the highest speed reasonably attained. Would like a speed of 18 knots, if possible.

The boat to be sea-going, capable of going through a "blow-hard," and to take care of four persons on a cruise.

W. W. WARD.

A.—A full answer to this query would require a complete design of the boat, and this we can scarcely undertake to furnish. You should rather apply to some of the leading builders of such craft.

In a general way it may be said, however, that you impose an almost impracticable schedule of conditions. A motor boat 40 feet in length may by special design and powering be driven up to a speed of 18 knots, but in such case the conditions would scarcely admit of a cruising, sea-going design capable of weathering a "blow-hard." If the latter conditions are the more important, then a good, comfortable boat, some 7 feet beam, 10 to 12 tons displacement, and with good free-board and sufficient power for a 10 or 12 knot speed, is all that should be undertaken. For a boat of this type and for this speed some 30 to 40 horse power would be required.

If, on the other hand, a speed of 18 knots is requisite, the design must be along entirely different lines. The beam could not exceed some 41-2 feet, and in every way the lightest type of construction would be required. The displacement would be somewhere about 5 tons with 60 to 80 horse power. Such a craft would be of small value for cruising purposes, and you would be very much better advised to be content with moderate speed and with good sea-going and cruising qualities.

Q. 180.—Can you give me a rule or formula for computing the necessary heating surface in a boiler for a given H. P. cylinder under the following conditions? The diameter of the cylinder is known and the point of cut-off is assumed to be so many inches of the stroke. Likewise the revolutions are assumed to be a certain number. From the three factors given, this particular cylinder will use so many cubic inches of steam per minute. Now, in compound-condensing marine practice, in power ranging from, say, 100 to 250 H. P. (boilers having natural draft only), with steam pressures from 125 to 175 pounds, what number of square feet of heating surface should be allowed for each cubic inch of steam used for fairly good, economical practice?

With most of the auxiliaries being independently steam-driven, say independent circulator, air pump, and boiler-feed pumps, about what per cent. additional H. S. should be allowed? This problem is usually treated in the books by computing the horse power which the engine develops; but one of the first and important factors a student meets is that vagary M. E. P., and to him who has had scant previous experience on which to proportion and build by comparison, it is unsatisfactory.

A. H. C.

A.—Your question states the problem of design in somewhat different terms from those usually employed. If M. E. P. is a "vagary," so also is the number of cubic inches of steam used in the high-pressure cylinder up to the point of cut-off, for, due to initial condensation, it will be far more than the mere volume of the cylinder up to that point. Rarely would the amount thus condensed be less than 15 to 25 per cent. of the amount admitted, so that the actual weight of steam required will be considerably in excess of that occupying the actual volume up to the point of cut-off. This is as difficult to estimate as the mysterious M. E. P.; so that, after all, it comes back to the test of actual experience.

Suppose that we assume moderate draft, burning 16 to 18 pounds of coal per square foot of grate, and evaporating, say, 9 pounds of water per pound of coal, and with a ratio of heating surface to grate of 30 to 35, and hence of coal to heating surface of about .5 and water to heating surface about 4.5. Let n denote the revolutions of the engine. Then experience indicates that under such conditions we should give to the boiler from $n \div 130$ to $n \div 160$ square feet of heating surface for each cubic inch of H. P. cylinder volume up to the point of cut-off. It should be noted that such proportion is intended to apply to steam pressures of 140 to 170 and to a ratio of L. P. diameter to H. P. diameter of about 2 to 1.

Thus, for illustration, suppose H. P. diameter equals 10 inches, stroke equals 14 inches, and revolutions equal 200, with cut-off at 60 per cent. Then volume of cylinder up to point of cut-off equals 660 cubic inches nearly. Taking $n \div 150$ as a fair figure per cubic inch, we have $200 \div 150 = 1.33$ square feet per cubic inch, and $1.33 \times 660 = 880$ square feet of boiler heating surface required.

Where most of the auxiliaries are used independently it will be well to add about 10 per cent. to the heating surface considered adequate for the main engine. In the present case this would give 88 square feet to be added, giving a total heating surface of $880 + 88 = 968$.

If we could have assumed a somewhat more lively rate of combustion, say 22 pounds of coal per square foot of grate surface, we could decrease the heating surface to the neighborhood of $n \div 200$ per cubic inch of cylinder volume up to the point of cut-off. In the present case this would reduce the amount to 1 square foot per cubic inch, and hence to a value of 660 square feet for the main engine and 66 for the auxiliaries, and hence to a total of 726 for the boiler as a whole.

Q. 183.—How would you calculate the thickness of the shell of a cylindrical boiler for a given diameter and pressure, say 6 feet diameter and 200 pounds pressure? Give formula for same. Give formula for finding diameter and spacing of rivets for the longitudinal seam. L. W. V.

A.—The information you ask for is all contained in the general Rules and Regulations of the Board of Supervising Inspectors of Steamboats, copy of which may be obtained gratis by applying to your local inspector or to the Supervising Inspector-General, Steamboat Inspection Service, Department of Commerce and Labor, Washington, D. C.

The formula for finding the thickness of shell is as follows: Let T = thickness of plate in inches; S = ten-

sile strength; P = pounds per square inch gauge pressure; r = radius, or 1-2 diameter, of boiler, in inches. Then

$$P = \frac{\frac{S}{6} \times T}{r} \quad \text{or} \quad T = \frac{6Pr}{S}.$$

Assuming the tensile strength at 60,000 pounds and the values of P and r you have given, we find the value of T as follows:

$$T = \frac{6 \times 200 \times 36}{60,000} = .72 \text{ ins.}$$

which is for single riveting. If double riveting is used the pressure may be increased 20 per cent., or the thickness may be reduced to an amount equal to dividing the above value of T by 120 per cent., or .60 inch, say 5-8 inch.

The diameter of steel rivets for steel plates is taken as the thickness of the plate + 3-8 inch. To find the pitch the following formula is used: p = pitch of rivets, in inches; T = thickness of plate, in inches, = 5-8 inch in this case; n = number of rivets per pitch, which is 2 for double riveting; d = diameter of rivet in inches = $T + 3-8$ inch, or 1 inch.

Then

$$p = \frac{23 \times d^2 \times .7854 \times n}{28 \times T} + d.$$

Substituting,

$$p = \frac{23 \times 1 \times .7854 \times 2}{28 \times \frac{5}{8}} + 1 = 3.064 \text{ ins.}$$

Q. 184.—I have been much interested in the article by Lieutenant H. C. Dinger on "Internal Lubrication of Marine Machinery," and especially that part of it which pertains to the use of graphite. I would like to ask of you and your readers if they know of a method or device for removing graphite from exhaust steam. I am heating water by the direct commingling of exhaust steam, but cannot use graphite (much as I wish I could) for the reason that the graphite will go along with the water and damage or ruin the manufactured stock with which it will come in contact. What effect would graphite have on the inside of boilers where it would be pumped direct from the surface condenser? R. H. H.

A.—We regret that we cannot give you positive information upon this point, and trust our readers who have had experience with graphite will advise us. Refrigerating companies use but little oil, on account of the oil being carried over and staining the ice. In place of the oil a small quantity of graphite is used, with much better results, although now and then a flake of graphite may show as a tiny black speck in the ice. We should imagine that you are using too much graphite. The theory of the use of graphite is that it will attach itself to the cylinder walls and pistons, and but little of it will pass out of the cylinder. As far as we know, no trouble results if graphite is carried into the feed water; in fact, graphite is sometimes used to prevent forming scale, the idea being that graphite will cover the boiler surface with a very thin film to which the scale will not attach itself.

Name Missing.—If our correspondent who writes from Ontario, Ore., on October 14, to inquire concerning a telephone magazine, will please send us his name, which he omitted from the letter, we will communicate with him.

TECHNICAL PUBLICATIONS.

Governors and Governing Mechanism. By H. R. Hall. Size 5 by 7 inches. Pp. 116, with 76 diagrams and folding plates. The Technical Publishing Company, Manchester, England. Price \$1.00.

The purpose of the author in the preparation of this book seems to have been the presentation in a simple form of such matter as will best aid the general student of engineering in his study of governors and governing mechanisms.

The earlier chapters deal, therefore, with general principles and with the simpler forms of such devices, leading up through the various forms of ball or pendulum governor to the many varieties of shaft governor now almost entirely in use on all engines of the high-speed class.

The treatment of the various types and varieties of ball governor with reference to steam-engine practice is especially full, perhaps more so relatively than that of the shaft and inertia governors which for so large a part of the field of modern practice, at least in the United States, have supplanted those of the older ball or conical pendulum type.

Following the discussion of the governor as applied to the steam engine, several of the leading types of gas-engine governors are taken up and discussed with reference to the special conditions to be fulfilled in such mechanisms. Following the subject matter proper of the book is found a numerous collection of illustrations and descriptive matter relating to governors as applied in modern practice to engines of both slide- and drop-valve types, as well as to air compressors, and to the difficult problem of controlling a marine engine under the tendency to race in a seaway.

The descriptive treatment throughout the book is excellent and the general discussion of principles involved is generally clear and sufficiently comprehensive for the purpose in view. Occasionally, as in the discussion of centrifugal force and the conical pendulum in the abstract, there is, perhaps, something to be desired on the score of clearness and cogency of presentation.

The author has rendered to engineers and students a real service by bringing together in a convenient collected form so much information regarding governing mechanisms of various types and for various purposes, and so good a general discussion of the conditions involved and of those to be fulfilled in order that the governor may display in proper combination the various qualities needed to make it effective for the purpose in view. The book may be cordially commended to all interested in this field of engineering practice.

The Slide Rule. By Charles N. Pickworth. Eighth edition. Size 5 by 7 inches. Pp. 104, with 19 figures in the text. New York, D. Van Nostrand and Company. Price 50 cents.

The first edition of this book, published in 1894, has been successively followed by other large editions, showing conclusively the favor with which it has been received throughout the engineering world. To the engineer of the present day the slide rule is almost as much of a practical necessity as the lead pencil. It has assumed a place as an aid in all manner of computations which it

is not likely soon to lose, and there has certainly existed a fair field for just such a practical manual as the present work. In the new edition several additions have been made to the contents, particularly in reference to such recent developments of slide-rule methods as are rendered possible by the use of the additional log. log. scales. Slight reference is also given to the use of the slide rule in the solution of certain equations of the second and third degrees. The subject matter as a whole presents first the fundamental principles of the slide rule, and then show its application to the great variety of computations to which it is adapted, including proportion direct and inverse, multiplication, division, finding of powers and roots, and combined operations of various kinds.

Illustrations are then given of the application of the method to various problems in mensuration, mechanics, engineering, trigonometry and surveying, etc. Reference is then made to the various slide rules of spiral, cylindrical, or circular form, and also to the various forms of combination rules for the solution of definite and special problems. The treatment of the subject is clear and eminently practical, and the book should prove a most welcome addition to the working library of every user of the slide rule, and especially to those not well acquainted with its capabilities and who may desire to familiarize themselves with the details of its use and with the wide range of application which the instrument has in the daily life of the practical engineer. To all such we would warmly recommend the book as one most admirably suited to their needs.

Naval Fleets of the World in 1903. By Commandant de Balincourt (French Navy). Size 6 by 4 1-2 inches. Pp. 842, with 403 schematic figures of ships and their armament. Paris, Berger, Levrault and Company. Price 6 francs.

At the present time, when the attention of the whole world is turned with such serious attention to the question of naval strength and armament, and when the rôle of the navy seems likely to become more and more important, compendiums of this character are of the greatest interest and value to every student of naval affairs. The purpose of this book is to present, under a condensed and schematic form, the fullest possible information regarding the warships of all maritime nations. The names of the countries are arranged in alphabetical order, and under each country is given first a brief résumé of the character and tendency of recent construction, with such general observations as the author has deemed appropriate to the case. Then follow on successive left-hand pages schematic sketches of the type ships of the navy under discussion, showing general form, distribution of masts, sail power, if any, with offensive and defensive armament. On the opposite pages are given in each case the names of the ships of that given type with a full statement of their size, power, speed, coal capacity, number and caliber of guns, thickness and distribution of armor, etc., together with such observations or criticisms as may seem appropriate. At the close of the volume is found a complete alphabetical index of all ships mentioned, with nationality and page where described.

The value of such books lies, first, in the quality of the information given, and, second, in the manner in which

it is presented. The data seem to have been compiled with great care and accuracy, and the character of the information furnished seems, therefore, to be all that could be desired, while its general arrangement and mode of presentation are excellent and enable the leading particulars of any given ship to be ascertained with the minimum expense of labor and time.

For English-speaking readers the book will, of course, be less available than if it were written in English, but the sketches with their indications are clearly independent of the language, and of themselves will be found to give in a graphic manner a vast amount of valuable information regarding the fighting quality of the ships thus indicated.

Railroad Car Charts. Three charts, 27 by 15 inches. Price, each, 25 cents; three for 50 cents. The Derry-Collard Company, 256 Broadway, New York, N. Y.

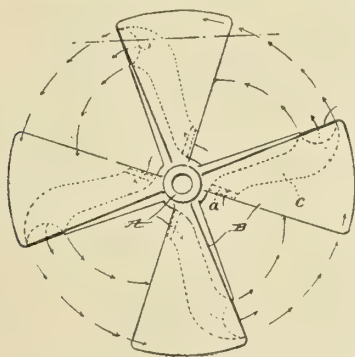
The value of diagrammatic instruction is well recognized, and the preparation of the three charts gives respectively: an anatomy of a box freight car, anatomy of a copper gondola car, anatomy of a passenger car. The publishers have presented large and clear charts of the construction of these different cars. The sections are made in such a way that the construction is clearly shown, each frame, beam, rod, etc., is prepared from diagram, and a key directly below gives the name of the part. They will be found most useful helps to those studying railroading.

SELECTED MARINE PATENTS.

736,951. MARINE PROPULSION. HERMAN H. FOWLER, OAKLAND, CAL.

Claim.—1. A spiral propeller for ships and boats, with hollow shaft to which are attached hollow blades formed by sheets of metal, which, at the shaft, are flanged outward, for fastening thereto, and, at the blade's edge, inward, for fastening together; suspended from the bottom and keel of the vessel, directly under and extending the full length of the keel, provided at the bearings with collars, to serve as thrust rings, and mitered gears by which to operate the propeller. Two claims.

736,952. SCREW PROPELLER. EDWARD FOX, BROOKLYN, N. Y., ASSIGNOR OF ONE-HALF TO WILLIAM LOGAN, ARLINGTON, N. J.



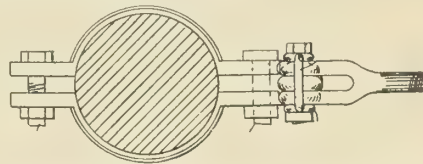
Claim.—1. A screw propeller comprising a hub, and a plurality of blades, pitched at an angle to the longitudinal median line of the hub; each of the said blades being provided with a passage which extends from the forward edge of the blade, with reference to the direction in which the propeller is rotated to drive a vessel forward, at a point adjacent to the hub, and in the direction of the length of the blade across the same, and terminates in a discharge, *b*, formed in the after side of the blade adjacent to the rear edge and outer end of the same, and disposed at an obtuse angle to the intermediate portion of the passage; whereby it is adapted to discharge a stream of water against the rear face of the following blade. Two claims.

737,021. SUBMARINE-CABLE-LAYING DEVICE. BEAUREGARD ROBERTS, MOBILE, ALA. Two claims.

737,078. PLATE FOR SHIPBUILDING. JOHN CHAPMAN, SUNDERLAND, ENGLAND.

Claim.—1. In structures where metal plates are joined together a plate overlapped on a plurality of its edges by other plates, said overlapped plate being joggled at a plurality of its corners and at a plurality of its edges, so that each overlapping plate is flush with the overlapped plate at points where both the overlapped and overlapping plates are overlapped by a third plate. Four claims.

737,118. FASTENING DEVICE FOR BOOMS. THOMAS S. LAUGHLIN, PORTLAND, ME.

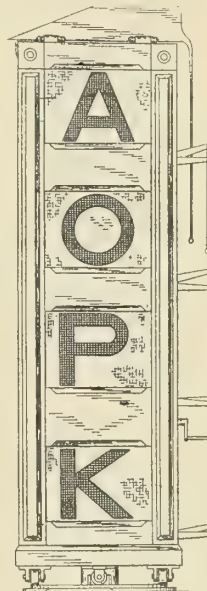


2. The herein-described device for fastening a boom to the mast, comprising a pair of semicircular bands, each provided with oppositely-extending-eyed lugs upon their ends, bolts removably securing said bands around the mast entering said eyes, a bracket mounted upon the forward bolt between the adjacent lugs of the bands and having a downwardly-projecting lug provided with an eye adapted to contact the mast, a screw entering said eye to secure the lug to the mast, said bracket also being provided upon its forward end with a vertical socket, a pintle pivotally mounted within said socket and an eyed lug projecting from the upper end thereof, a screw adapted to enter the end of the boom having eyed portions, a shackle having eyed portions, and a bolt adapted to pass through the eyed lugs of the pintle and the eyed portions of the screw and shackle for securing the shackle and boom carrying the screw to the pintle. Two claims.

737,213. PROPELLING APPARATUS FOR VESSELS. LEON DION, BOSTON, MASS., ASSIGNOR TO AMERICA MARINE COMPANY, NEW YORK, N. Y., A CORPORATION OF SOUTH DAKOTA.

Claim.—1. A vessel having a longitudinal channel in its hull, a drive wheel located in the said channel, having two slotted perimeters separated by an intermediate peripheral space, and a chain composed of a series of units, each including a paddle, and coupling members rigidly affixed thereto, the paddle being formed to engage the slots in the perimeters of the wheel, while the coupling members are formed to enter the spaces between the said perimeters. Five claims.

740,939. MARINE SIGNALING APPARATUS. WILLIAM J. SMITH, SEATTLE, WASH.



Claim.—1. A signal apparatus, comprising a containing case having sight apertures in the front thereof, translucent screens having opaque characters marked thereon, lead rolls for said screens, vertical spindles, spools loosely mounted on said spindles, clutch devices splined to said spindles and adapted to engage the said spools thereto, levers for actuating said clutch devices, worm wheels on said spindles, another spindle arranged transversely to aforesaid spindles and having screws thereon adapted to engage said worm wheels to rotate said first-named spindles, means to rotate the transverse spindle, a brake device substantially as described for each of said spools, lights positioned opposite said case apertures in the rear of the screens, and a reflector. Three claims.

740,946. MARINE PROPULSION. ALBERT J. TAPLIN, WASHINGTON, D. C. Five claims.

741,084. WAVE MOTOR. WILLIAM L. WALTER, PORT HURON, MICH., ASSIGNOR OF ONE-HALF TO MARCIA M. RICHARDSON AND SAMUEL W. SMITH, PONTIAC, MICH. Nine claims.

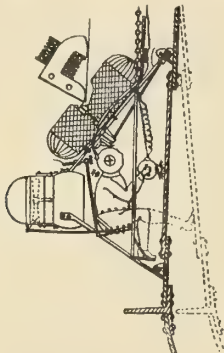
741,227. METHOD OF MAKING ANTI-FOULING COATINGS. GEORGE D. COLEMAN, BOSTON, MASS., ASSIGNOR, BY MESNE ASSIGNMENTS, TO COLEMAN SHIP COPPERING COMPANY, A CORPORATION OF MAINE.

Claim.—1. The method of making anti-fouling coatings for ships' bottoms or structures submerged in or exposed to the action of water, and particularly sea water, which consists in applying to the surface to be coated a layer of quick-drying paint, in projecting particles of finely-divided metallic copper into the surface of this layer of paint while it is still moist, in rubbing or hammering or burnishing the coating to force the particles of copper into the paint to embed them in and envelop them by the paint, in applying still more finely divided metallic copper to the paint which comes to the surface between the particles of copper first applied, and in rubbing or hammering or burnishing the coating to present a smooth surface closely studded with particles of bare metallic copper.

2. The method of making anti-fouling coating for ships' bottoms or structures submerged in or exposed to the action of water and particularly sea water, which consists in applying to the surface to be coated a layer of paint composed of a mixture with cement or paint substance formed of red lead and linseed oil intimately united by baking, of a varnish, in applying to this layer of paint, while still moist, finely-divided metallic copper, in rubbing or hammering or burnishing the surface of the coating to embed the particles of copper in and envelop them by the paint, and to bring the paint to the surface around the particles of copper, in applying still more finely divided metallic copper to the paint so brought to the surface, and in rubbing or hammering or burnishing the surface of the coating to present a smooth surface closely studded with bare particles of finely-divided copper, substantially as described. Two claims.

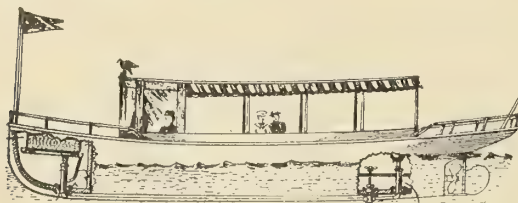
741,228. ANTI-FOULING COATING. GEORGE D. COLEMAN, BOSTON, MASS., ASSIGNOR, BY MESNE ASSIGNMENTS, TO COLEMAN SHIP COPPERING COMPANY, A CORPORATION OF MAINE. Two claims.

741,298. APPARATUS FOR CLEANING AND TREATING SHIPS' HULLS, ETC. HAROLD BINNEY, NEW YORK, N. Y.



Claim.—1. The combination for cleaning or treating ships' hulls, or other objects under water, of an open floating frame forming a seat or support for the diver, with power-actuated mechanism for bringing the same in contact with said hull, and power-actuated mechanism for treating the said hull, and electrical connections from a suitably distant source of current to the said mechanisms. Six claims.

741,512. MARINE VESSEL. CHARLES H. LEE, SOUTHAMPTON, N. Y.



Claim.—1. In a marine vessel, a system for supplying and distributing fuel to an engine, having a fuel pipe located outside of the hull and provided with a branch extending into said hull, and a standpipe open to the water and surrounding said branch of the fuel pipe. Ten claims.

741,683. GYROSCOPIC APPARATUS FOR STEERING TORPEDOES. FRANK M. LEAVITT, BROOKLYN, N. Y., ASSIGNOR TO E. W. BLISS COMPANY, BROOKLYN, N. Y., A CORPORATION OF WEST VIRGINIA. Three claims.

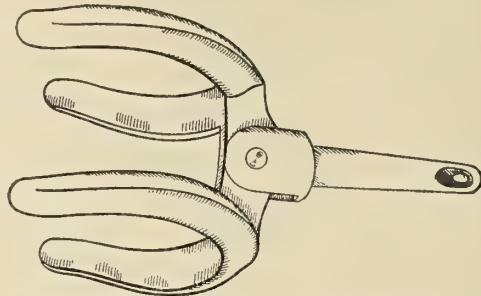
741,707. LOCOMOTIVE. HENRY E. PARSON, BROOKLYN, N. Y.

741,769. ANTI-FOULING COATING FOR METAL STRUCTURES. GEORGE D. COLEMAN, BOSTON, MASS., ASSIGNOR, BY MESNE ASSIGNMENTS, TO COLEMAN SHIP COPPERING COMPANY, A CORPORATION OF MAINE.

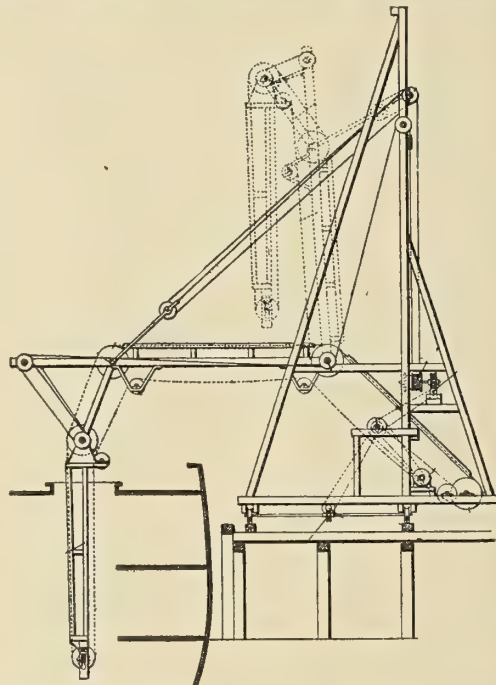
741,850. ROWLOCK. JOHN R. SUPPLE, OAKLAND, CAL.

Claim.—A rowlock formed with a suitable stem, a cross arm pivoted to said stem and at essentially right angles thereto, a yoke at each extremity of said stem and equidistant from said

pivot, said yokes being open at their upper portions to receive the oar. One claim.

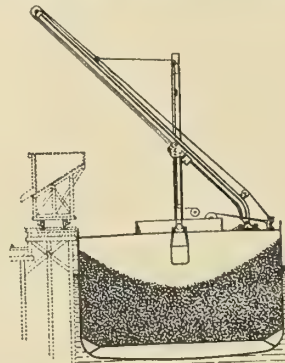


742,023. APPARATUS FOR LOADING OR UNLOADING VESSELS. BEVERLY J. HARRIS, NEW ORLEANS, LA.



Claim.—1. In a loading or unloading apparatus, the combination with a platform, of a frame and a motor mounted on said platform, a swinging frame pivoted to said frame, hanging frames pivotally connected to said swinging frame, idlers mounted in pairs in said frames, dumping idlers mounted near the lower end of the lower hanging frame, and an endless looped apron passing between said idlers. Five claims.

742,101. BARGE. GEORGE E. TITCOMB, PHILADELPHIA, PA., ASSIGNOR TO THE DODGE COAL STORAGE COMPANY, NAUGATUCK, CONN., A CORPORATION OF CONNECTICUT.



Claim.—1. The combination of a vessel, a mast, a rail on the deck of the vessel, a slide adjustable on the rail, a block swiveled in the slide, and a boom pivoted to the block and guyed to the mast, with hoisting mechanism carried by the boom. Four claims.